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THE NATIONAL PARKS COMMISSION

THE fourth annual report of the National Parks Commission*, which covers the year ended September 30, 1953, contains a record of some useful work carried out under disheartening difficulties. Progress is reported in regard to the 'long-distance routes': proposals for a Pembrokeshire Coast Path and for a Cornwall South Coast Path were submitted during the year and the former has been approved by the Ministry. It is clear that the Commission's advice on development questions is being freely sought; the Commission was successful in securing a modification, acceptable to all parties, of the route originally proposed for the 275-kV. grid line from Newcastle to Carlisle, which was to run through part of the area suggested by the Hobhouse Committee as the Roman Wall National Park. It has been less successful in the defence of the Peak District National Park against encroachment of mineral working, especially limestone quarrying. Except for his decisions on the Gantries Hill and Hartington new proposals, and the reopening of the Cotterhole working, the Minister of Housing and Local Government's decisions were far removed from the recommendations of the Commission and those of the Peak Park Board. The Commission is also manifestly uneasy about the Services land requirements; here again it would appear that the Services have been allowed to judge their own cause and to claim, as essential to defence, areas of great natural beauty in which such developments are clearly undesirable.

Despite, however, the existence of a considerable measure of goodwill, manifested, for example, in the numerous examples of development proposals handled by the Commission, as detailed in Appendix *B* to this report, the Commission's fourth report is a record of frustration and disappointment which may well prompt the question whether it was worth while establishing the Commission at all.

So far as the public is concerned, it is clear from the Commission's fourth report that there are still widespread misapprehensions as to the nature of a national park, and the effect of designation of an area for that purpose on public access or on farming and other activities in the area. Some at least of the opposition to the Commission's proposals for designation is due to such misconceptions, and it might in practice be sounder policy to concentrate on the task of education rather than, as the Commission itself seems inclined to do, to accelerate the process of designation. It is true that the Commission is naturally and rightly anxious to complete the process before spoliation or encroachment by public bodies has gone so far that irretrievable damage has been done to the areas indicated in the Hobhouse Committee's report. Nevertheless, designation alone is ineffective unless an appropriate administrative authority is created. So long as the Minister of Housing and Local Government and also Parliament refuse to face this issue,

* National Parks Commission. Fourth Report for the year ended September 30, 1953. H.C.18. (H.M.S.O., 1953.) 2*s.* 6*d.*

local authority parks such as we are now being given cannot be protected adequately against the inroads of government departments and public corporations.

The creation of the North York Moors National Park brought the total area of the six national parks in England and Wales to some 3,400 square miles. Since the report was signed, the chairman of the Commission has signed, on December 7, 1953, an order designating some 680 square miles in the North and West Ridings of Yorkshire, while on January 27, in spite of the opposition of the Devon and Somerset County Councils, to which the report refers, an eighth area was designated in the Exmoor National Park. The Commissioners, however, in this report record some disappointment at the progress now being made in the designation programme; and in the main this disappointment appears to be due to the greater reluctance now encountered on the part of local authorities to concur in the designation of national parks within the area of their responsibility.

One example is Exmoor, already noted. Another instance is to be found in the proposals for a Cornwall National Park. Consultations with the eighteen local authorities concerned began in June 1952, and, as the report notes, the proposal of the Commission that the county's coastal territory should be designated a national park received a warm welcome. In spite of this, local doubts and reservations eventually led to a recommendation of the Cornwall County Council that the project should be deferred *sine die*. The Commission replied that it could not acquiesce in the suggestion that the intentions of the National Parks Act, as the Commission interprets them, should be suspended in this way in Cornwall, and although the County Council declines to comment on the boundaries proposed for the park, the Commission proposes to renew discussions at the appropriate time.

The Commission's disappointment arises in general from the fact that previously such reluctance to consider readjustments in local administration involved by the Act as a corollary to the designation of any given area had usually been overcome more or less successfully. It now appears that not only do misapprehensions as to the purposes and effects of the national parks persist and prejudice the reception of proposals, but also that the economic atmosphere is more unpropitious, for local rates have risen and increased the unwillingness to countenance change. Generally speaking, the Commission believes that the administrative consequences account for the reluctance of local authorities to implement the National Parks Act in their areas. It is not easy to demonstrate to those who are suspicious or sceptical even the short-term and palpable advantages accruing to local rate-payers from the designation of a national park in their area. Although, the report continues, the parks now in operation are taking in their stride, as it were, the anomaly of local authorities carrying the burden of responsibility for a national park, it remains an anomaly which becomes more of a stumbling block to new entrants to the scheme in times of financial stringency.

The National Parks Commission makes no criticism of Government policy; but it is perfectly frank and realistic. Its fourth report makes it crystal clear that the present unsatisfactory position is due to the failure of the Minister of Housing and Local Government to deal with the critical issues of finance, administration and local government reform. If the latter issue were handled with imagination and sympathy as well as wisdom, neither the financial nor administrative obstacles to the implementation of the National Parks Act would be so serious. In the absence of such reform, the intentions of the Act cannot be implemented.

There is no suggestion in this report that the views of the local authorities are to be disregarded. The Commission recognizes as clearly as the Minister himself that the success of the concept of the national parks scheme in Britain depends upon the willing co-operation of the local authorities, and it is anxious to proceed with the utmost degree of agreement attainable between the local authorities concerned and itself. In fact, the brightest feature of this report, as of the preceding report of the Commission, is the evidence it contains of a large measure of co-operation and goodwill.

A conspicuous example is to be found in the Peak Planning Board, which has won the warm support of some who originally opposed its formation. Generally speaking, the Commission believes that the planning boards or committees which have come into existence during the past three years are exercising their powers with growing resolution and with effect. Liaison between them and the Commission is growing, and the Commission takes the reasonable view that these boards and committees must be allowed time to grow. Spectacular or immediate results should not be demanded of them or of the Commission, but nevertheless the inherent limitations in the structure of the boards and in the powers of the Commission should be kept in mind: it is only subject to those limitations, and not according to the full intentions of the National Parks Act, that claims of amenity and beauty and of recreational facilities are being safeguarded.

The details of administrative arrangements in the six areas thus designated as national parks given, without further comment, in an appendix to this fourth report, show the magnitude of the deviation from the arrangements laid down by Parliament in the Act. The success of the Lake District Planning Board and the Dartmoor National Park Committee in dealing with specific matters such as caravaning and camping does not alter the fact that these and other park planning boards and committees have neither the constitution nor the independence which would enable them to take a national point of view, or the authority to resist encroachment, which Parliament intended they should enjoy.

There is thus good reason for welcoming the national campaign for the full operation and ultimate amendment of the National Parks and Access to the Countryside Act, which was launched at a week-end conference at Longshaw House last autumn, convened by the Ramblers', Youth Hostels,

and Co-operative Holidays Associations and the Holiday Fellowship. Informed public opinion and its influence on Parliament are the surest means of securing that the intentions of the original Act are implemented or any satisfactory amendments made to that Act. As Mr. A. Blenkinsop pointed out at the conference, not much help can be expected from Parliament until the objectives of national parks are widely understood and more general enthusiasm is manifested for them.

The first need, accordingly, is, as has already been indicated and as was recognized at this conference, for a positive educational campaign on the part of the National Parks Commission and of the rambling and amenity organizations concerned. If the Commission's efforts are still hampered by lack of funds, the voluntary organizations could render valuable help in this task. Quite apart from the fact that, as the conference agreed, these organizations sometimes need to improve their own outlook, co-operation in the task could help to bring home to a large section of the community that a price has to be paid for amenity, and that ultimately the existence and effectiveness of national parks in Britain depend on the effort and resources the community is prepared to devote to that purpose.

Such an educational campaign must obviously include local authorities; their understanding and co-operation are essential if the objects of the national parks are to be achieved, though in the main it is through Government action, both financial and in regard to local government reform, that the reluctance of the local authorities to co-operate will be removed. On the second point, indeed, as is becoming apparent through the foot-paths survey and through the liaison between the Nature Conservancy and local nature reserves, the administration of the national parks offers an opportunity which, used with imagination, could bring fresh vitality to the local units. On the question of finance, Lord Chorley maintained at the conference that the national parks should get at least £1 million a year and that the Hobhouse Committee had been led to expect at least that amount.

Meanwhile, we can expect no more than that the National Parks Commission will be able to prevent irreparable damage until such an educational campaign as was projected at Longshaw has the appropriate effect on public opinion. Since the present report was published, the waterworks committee of one of our largest conurbations, without the knowledge of the city council and disregarding the findings of the Committee on Gathering Grounds and the intentions of Parliament, has sought to obstruct access to the Pennines and to get the decision of the National Parks Commission on the Pennine Way overriden by direct approach to the Minister. If, however, it proves impossible to rouse public opinion to insist that Parliament should no longer allow the purposes written into the existing Act to be flouted, repeal of the National Parks and Access to the Countryside Act would seem to be the wiser course. Respect for the law would then no longer be undermined by official indifference or local obstinacy, and a salutary check might be given to the disposition in a modern democracy to expect that benefits can be obtained without either payment or effort on the part of beneficiaries. National parks, as the Commission observes in this fourth report, are not museum pieces. The danger, however, is not of stagnation on the part of the Commission but rather of inaction on the part of Government. Only an upsurging of public opinion, fully aware of what is at stake and prepared to pay the price involved in terms of finance or other resources, of legislation and of unceasing vigilance, is likely to bring Parliament or Government to the sense of urgency and to the action required to ensure that the prospect opened up by the successive reports of the Hobhouse and Huxley Committees does not fade away and the national parks and nature reserves prove no more than a mirage.

THE ACCRETIONARY ORIGIN OF COMETS

The Comets and their Origin
By R. A. Lyttleton. Pp. x+173+13 plates. (Cambridge: At the University Press, 1953.) 25*s*. net.

THE primary object of this book is the exposition of Dr. R. A. Lyttleton's own very interesting theory of the origin of comets, and he has set out "to lay this theory before as wide a circle of astronomers as possible". To render the book complete in itself, he has wisely decided to include an account of the main observational features of comets, and the first two chapters accordingly summarize our present knowledge of their dynamical and physical properties. There follows Chapter 3, which gives the core of the author's theory. He applies the theory of accretion to the passage of the sun through an interstellar dust cloud, and he finds that the result will be the formation of aggregates of interstellar dust describing nearly parabolic orbits around the sun. The orbits of these aggregates would afterwards be modified by planetary perturbations. There is no reason to doubt that the sun may have passed through interstellar dust clouds during its history, and Dr. Lyttleton has now shown that the result of such a passage will be the formation of aggregates of cosmic dust which, when quantitative estimates of size and density are taken into account, seem to be remarkably like comets.

The plausibility of this identification is strengthened in Chapter 4. Here Dr. Lyttleton is led to the conclusion that near the perihelion passage of one of his dust aggregates collisions will operate so as to pulverize some of the particles, and in this way dust may be produced which is fine enough to respond to the radiation pressure of sunlight. This very fine pulverized dust would be blown away from the sun and would so form a 'tail'. The reader is here left with the impression that Dr. Lyttleton's dust aggregates formed by accretion look still more like comets.

The last chapter discusses the relation of the author's theory to earlier ideas, and no special comment on this chapter seems to me to be necessary. With regard to the theory as a whole, it must be emphasized that Dr. Lyttleton has gone some way towards working it out on a quantitative basis with the view of the comparison of his aggregates of dust with comets as we know them. So far, the working out seems to support the hypothesis. Naturally, to

quote Dr. Lyttleton's own words, "there is room for further investigation at many if not all points". A good deal of the working-out process is given in some detail in the book, but the mathematics involved is elementary, and the author has fulfilled his aim of catering "for as wide a circle of astronomers as possible". The book is readable, its standard of presentation is high, and there are some excellent plates and a valuable bibliography.

Dr. Lyttleton has made out, to say the least, a good *prima facie* case, and he has every right to expect that his theory be regarded as meriting detailed and searching analysis and criticism. His book is to be commended to all interested in the subject.

W. M. H. Greaves

THE PHILOSOPHY OF DESCARTES

New Studies in the Philosophy of Descartes

Descartes as Pioneer. By Prof. Norman Kemp Smith. Pp. xii+369. (London: Macmillan and Co., Ltd., 1952.) 25*s*. net.

Descartes' Philosophical Writings

Selected and Translated by Prof. Norman Kemp Smith. Pp. vii+316. (London: Macmillan and Co., Ltd., 1952.) 25*s*. net.

IT is surprising how little of interest or importance has been written in English on the philosophy of Descartes, in view of the extent to which his main writings are still read by students of philosophy in Britain; by comparison, English work on Spinoza, who is now virtually unread, is of far greater significance. Until the publication of Dr. L. J. Beck's "The Method of Descartes" last year there was no large-scale study in English of Descartes's contributions to logic and scientific method, and even now we lack an adequate discussion of his metaphysics. Prof. Norman Kemp Smith's "New Studies" go some way to fill the gap: making full use of the results of recent French scholarship, they examine Descartes's thought stage by stage and show how his preoccupation with first-hand scientific issues led him to enunciate a clear-cut doctrine of method and a bold metaphysical dualism which he later, with doubtful consistency, qualified in the hope of bringing them into more obvious accord with the facts.

As a contribution to the history of thought, the book is interesting if not conspicuously original; read as an independent discussion of some of Descartes's leading philosophical theses, it is less satisfactory. It is well to stress, as the author does, the pioneer spirit which underlay Descartes's enterprise to provide a purely mechanistic physiology, especially when one remembers the state of knowledge at the time. As the "Discourse on Method" makes clear, it was to medicine and mechanics, not to mathematics or even philosophy, that Descartes hoped to make permanent contributions. But it should surely be stressed on the other side that, if Descartes here showed some of the insight of genius, he also betrayed all too clearly the defects of his qualities; for, despite many disappointments, he never gave up the idea that a final science of Nature could be arrived at, and, as Gilson and others have demonstrated, he never gained a sufficient understanding of the importance of facts. Hence his account of scientific method is at once strikingly right and alarmingly wrong.

But it is when we turn from logic to metaphysics that the defects of Prof. Kemp Smith's treatment are most obvious. We learn from his book why Descartes was inclined to metaphysical dualism and how his position was afterwards modified by his recognition that (in his own words) "I am lodged in my body not as a pilot in a ship, but so intimately conjoined, and as it were intermingled, with it, that with it I form a unitary whole". There is an interesting discussion of what the author calls "natural beliefs" in this connexion, in which it is argued that Descartes anticipated Hume, but nothing whatsoever is said of the attacks made in recent years on Cartesian metaphysics as resting on a series of "category-mistakes". It may be that these attacks are crude, but they are not too crude to be taken seriously. Similarly, Descartes's "hyperbolical" doubt is expounded in his own terms, and the limitations with which he used it are clearly brought out; but no attempt is made to meet the criticism of this sort of scepticism expressed by writers like Wisdom. Nor are the logical subtleties of the *cogito* argument explored as they deserve to be.

Prof. Kemp Smith has supplemented his "New Studies", which replace an older volume of his published fifty years ago, by a new translation of a selection of Descartes's philosophical writings. He has done this, he writes, because he finds existing versions, whatever their merits, to be written with insufficient understanding of Descartes's views and often with insufficient attention to the nuances of his vocabulary. These are good reasons for making fresh translations, and when the translator is as practised and successful as Prof. Kemp Smith the work is doubly welcome. It is perhaps a pity, however, that he did not offer to revise and expand the Cambridge translation by Haldane and Ross instead of producing a volume which is necessarily incomplete; and he might well have confined his notes entirely to philological matters and abstained from comment on matters of substance, seeing that his comment has to be highly selective and in fact varies considerably in bulk from treatise to treatise.

W. H. Walsh

THE WORKS OF GEORGE BERKELEY

The Works of George Berkeley, Bishop of Cloyne

Edited by A. A. Luce and Prof. T. E. Jessop. (Bibliotheca Britannica Philosophica.) Vol. 5: Siris, Three Letters to Thomas Prior, A Letter to the Rev. D. Hales, Farther Thoughts on Tar-water, Varia. Edited by Prof. T. E. Jessop. Pp. xi+236. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1953.) 30*s*. net.

THE fifth volume of the new edition of Berkeley consists of his last major work, with minor writings related in subject-matter. "Siris" advocates practical therapeutic measures in terms of scientific theories now obsolete, depending on philosophical concepts now almost forgotten. In its own day "Siris" was Berkeley's most popular work. His tar-water, which long survived in the "Pharmacopœia" as *aqua picis*, served a useful purpose—a mild antiseptic for internal or external application that could do no harm and might do much good in many common ailments. It could be prepared by any housewife from common ingredients at trifling expense. It is true that Berkeley thought of it as a

panacea, but panaceas were still respectable. In his arguments he used the best available medical knowledge. These arguments were much better than those for the Brunonian system of therapy, which had some professional support later during the eighteenth century, and as good as those for the homœopathic system which enjoyed considerable popularity during the nineteenth century. But his arguments were based on alchemical concepts and are now almost unintelligible. They are interesting, though, because they bring out very clearly the underlying metaphysics, from which alchemy derived its genuine, as apart from its fraudulent, appeal.

This metaphysics is the ancient faith in the Great Chain of Being, a faith practically universal in folklore and prevailing in most Greek philosophy. Even the atomist Lucretius, who should have repudiated it, is strongly tinged with it. It is well summarized in a sentence from one of the early "Hermetic" works which Berkeley quotes. "All parts of the world vegetate by a fine subtle ether, which acts as an engine or instrument, subject to the will of the supreme God". It requires only the further statement, that there is one universal material substrate which this ether informs or transforms, striving to bring into existence more perfect from less perfect forms. Any modern who is shocked by this kind of view should read Newton on natural transformations in Query 30, appended to his "Opticks". He should note that where he differs from Newton and Berkeley is in the metaphysics he uses to order the evidence before him far more than in the evidence itself, which could all be taken in alchemical terms.

Prof. T. E. Jessop provides a useful introduction, in which he disposes of the claim that the thought of "Siris" is inconsistent with Berkeley's earlier works. He has also hunted up the often very obscure references given in the text, and has printed in an appendix the passages in Boerhaave's "Elementa Chemiæ" of which Berkeley makes extensive use. Altogether, it is a volume of which editors and publishers may well feel proud. A. D. RITCHIE

BAND SPECTRA OF DIATOMIC MOLECULES

Tables de Constantes et Données numériques

5 : Constantes sélectionnées. Atlas des longueurs d'onde caractéristiques des bandes d'émission et d'absorption des molécules diatomiques. Établi par R. F. Barrow, A. D. Caunt, A. R. Downie, R. Herman, E. Huldt, A. McKellar, E. Miescher, B. Rosen et K. Wieland. Pp. 390. (Paris : Hermann et Cie., 1952.) 5600 francs.

FOR atomic spectra, tables of collected measurements of lines arranged in order of wave-length are of considerable value for identification ; indeed, books such as Kayser and Ritschl's "Hauptlinien" and Harrison's "M.I.T. Wavelength Tables" are indispensable. There is a natural tendency to attempt a similar project for the banded molecular spectra. However, the problem is different and much more difficult. Whereas individual lines can often be measured with great precision, band spectra are more often observed with rather small dispersion, and the accuracy of measurement is much less. Even with big dispersion, the exact location of the band heads is complicated by the rotational fine structure of the bands, the choice of head position often depending to some extent on the instrument used, the source in which the band is excited and even on the observer. Often, too, there are complications due to overlapping rotational structure from another band. Whereas for atomic spectra each main electronic transition is responsible for a single multiplet of relatively few lines, with molecules each transition leads to a whole band system, and it is usually preferable to try identification of systems rather than of individual bands.

Volume 4 of "Tables de Constantes sélectionnées" was produced in 1951 by the same authors as the present volume, and contained a very useful collection of data of the spectra and molecular constants of individual diatomic molecules. The present volume is essentially a supplement to this, and most of the previously listed bands, with a few more from recent literature, are grouped into one table, containing nearly 13,000 heads of 299 molecules. They cover the wave-length range 15,050–672 A. For each band the direction of degradation, emitting molecule, electronic transition (where known), vibrational transition, and up to four of the characteristic or strongest bands of the system are listed. No indications are given of the appearance of the band (that is, how many heads), the type of sources in which it may be expected or intensity relative to others of the system. The term "Atlas" should not be translated literally ; there are no photographs or diagrams. The volume also includes wave-length lists, involving 2,500 heads, of bands of C_2, CH, CH^+, CN, CO, CO^+, N_2, N_2^+, NH, NH^+, NO, O_2, O_2^+, OH and OH^+ separately ; these are mere lists of wave-lengths without indication of direction of degradation, system or intensity, and it is difficult to imagine any use for them. The volume also contains a list of about four thousand lines of H_2, with their transitions.

It is natural to compare this volume with Pearse and Gaydon's "Identification of Molecular Spectra", an earlier attack on the same problem. This also included a much shorter list of principal band heads in order of wave-length, but relied mainly on photographs and individual tables. The present volume has the advantage of including the photographic infra-red and far ultra-violet regions, but the disadvantage that it is strictly limited to diatomic molecules, whereas Pearse and Gaydon included the main triatomic and polyatomic molecules and also gave indications of band appearance and sources in the main list. The much greater size of the table in the volume under review is not necessarily a big advantage. In the main visible and near ultra-violet region there are three or four bands to an angstrom, so that with the normal accuracy of measurement several chance coincidences will inevitably occur for each band head. In many cases the selection of material seems poor. Thus, as examples, about fifty heads of BaBr are listed around 5400–5150 A., whereas the six main sequence heads should be sufficient ; for the extensive $B \rightarrow X$ system of Te_2, about a hundred heads are included. This does not really make identification more certain ; it merely confuses the issue by increasing the number of chance coincidences.

The volume can, of course, only be made use of in conjunction with the previous Vol. 4, and in view of the limited usefulness of tables of this kind, unless supplemented by photographs, the high price would seem to put it in the luxury rather than the utility category. A. G. GAYDON

Elsevier's Encyclopædia of Organic Chemistry

Edited by F. Radt. Series 3: Carboisocyclic Condensed Compounds. Vol. 14, Supplement, Triterpenes. Co-edited by Dora Stern. Pp. xxxii+939S–1346S+Ind. 50. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1952.) £11 to subscribers.

IN the original Vol. 14 of this "Encyclopædia", published in 1940, 85 pages were devoted to a survey of the chemistry of the triterpenes. The fact that 407 pages of this supplementary volume are needed to summarize the literature belonging mainly to the period 1937–46 reflects the enormous amount of attention given to this considerable group of natural products during the decade. There seems every justification for the claim that the literature concerning the structures of the compounds is covered up to 1952. To a very large extent these structures have now been fully established, and several of the major groups of triterpenes have been inter-related. A number of gaps could now be filled by work which has been published since the appearance of the present volume, and much could now be written of the stereochemical relationships, which receive scarcely any mention.

The general characteristics of Elsevier's "Encyclopædia" are now so familiar that it is unnecessary to reiterate them. The usual excellence of production is maintained, and the features which are especially attractive in this volume include the following: the elaborate but beautifully clear charts illustrating conversions and reactions of the various groups of triterpenoids; a systematic list of compounds arranged according to the carbon skeletons which their molecules contain; and an alphabetical list of natural triterpenoids, grouped together in the index. It is quite an achievement to have found a misprint: this occurs in the first line, where the year 1945 is erroneously given as 1941.

It is a foregone conclusion that this volume is now in constant use by all workers in the field. It is safe to predict that it will also arouse the interest of a much wider circle of chemists.

Advanced Experiments in Practical Physics

By J. E. Calthrop. Second edition, revised throughout by Dr. J. A. Pryde. Pp. xvi+144. (London: William Heinemann, Ltd., 1952.) 10*s*. 6*d*.

IT is a pleasure to welcome the revised version of Mr. J. E. Calthrop's excellent book, even though it was not possible for this revision to be done by the original author. In producing the second edition, Dr. J. A. Pryde has accomplished a not too easy task in a very satisfying way, and, as is inevitable in such cases, certain alterations have been made, particularly in the section on electricity and magnetism, while new experiments dealing with valves, dielectric constant, conductivity and thick lenses have also been included.

To those who are not acquainted with Mr. Calthrop's book—and surely there can be few honours physics students in Britain who are not—it is only necessary to suggest that they should remedy this deficiency without delay. The book is designed specially for honours students and contains a series of fifty-five experiments grouped in three sections; and although the experiments vary in their standard of difficulty, each one is interesting and should be of inestimable benefit to the student from the point of view both of acquiring knowledge and of improving technique in practical work. The book concludes with a collection of additional problems and a list of useful books on the practical teaching of physics.

The standard of work set and presented by Mr. Calthrop was very high; the new edition certainly preserves that standard, and the book can be thoroughly recommended.

General Topology

By Prof. Waclaw Sierpinski. Translated by C. Cecilia Krieger. Second edition. (Mathematical Expositions, No. 7.) Pp. xii+290. (Toronto: University of Toronto Press; London: Oxford University Press, 1952.) 48*s*. net.

STARTING with the definition of a Frechet (*V*) space, and making no assumptions concerning the 'neighbourhoods' involved in the definition, Prof. W. Sierpinski proceeds, in Chapter 1, from derived set to closed and open sets. The open sets so defined are seen to satisfy the axioms for a topological space except that the intersection of two open sets may not be open. With these 'minimum' assumptions, several theorems on continuity, separation, connectedness and compactness are established; these extend considerably the results in Chapter 1 of the first edition of the book.

In Chapter 2, axioms for a topological space are assumed, After spaces the topologies of which have a countable base have been considered, Hausdorff spaces which satisfy the first countability axiom are studied; this makes a change from the first edition.

The remainder of the book covers approximately the same ground as the first edition, but with some deletions, some additions, and several improvements, notably in the shape of problems and examples. There are also changes in terminology to conform with standard usage introduced since the first edition was published.

The appendix by C. C. Krieger on cardinal and ordinal numbers is almost unchanged from the first edition. R. G. Cooke

Calculus

By Prof. C. R. Wylie, Jr. Pp. x+565. (London: McGraw-Hill Publishing Company, Ltd., 1953.) 48*s*.

THE distinctive feature of this first course in calculus is the great care taken by the author to make the subject interesting and intelligible to students of limited ability and small preliminary knowledge, who are told in advance the objective of each discussion, why a particular method is used, and what pitfalls have to be avoided. It is commendable that the author has scrupulously avoided the unsound arguments that occur in many elementary books. When the sound proof is too difficult for the beginner to understand, the theorem is stated without proof, for which a reference is given to a more advanced book.

The first chapter gives an excellent general outline of the leading ideas of both differentiation and integration. The later chapters go beyond most first courses, and include some account of physical applications, partial differentiation, multiple integration, Fourier series and differential equations. There are a great many examples (all with answers), a summary at the end of each chapter, an index, tables, formulæ from other branches of mathematics, and a glossary of technical terms. The only defect of the book is its high price. H. T. H. Piaggio

THE ELECTRON MICROSCOPE IN BIOLOGY*

By Dr. RALPH W. G. WYCKOFF, For.Mem.R.S.
Science Attaché, American Embassy, London

TWO recent developments in the human mind have contributed to produce modern natural science. One is a more acute sensory perception and objective awareness of the outer world. The other is an equally striking enlargement of the intellectual ability and willingness of many men to deal with these clearer perceptions of Nature, to relate them logically one to another and to devise from these relationships a consistent pattern of outer happenings. This enhanced sensory awareness of external reality expressed itself in the painting and sculpture of the Renaissance; and more or less simultaneously there arose, sometimes in the same individual, that closer and more purposeful observation of natural phenomena which was a root of modern science. In art this clearer perception enriched immeasurably the world of human values which art serves; in science it began to furnish that basis of external fact which must underlie any sound understanding of the meaning of human existence.

Only a rudimentary natural science could, however, have arisen from such unaided observation, no matter how acute, or how carefully it was analysed. The intimate knowledge we now possess of the texture of the universe is the direct result of the invention and use of instruments to extend and render ever more quantitative the limited information our senses can supply.

Vision is, of course, the sense that has taught us most about Nature; and it is therefore natural that instruments which extend its range will have been most actively sought and most highly valued. It was the telescope that gave a first practical demonstration of the essential role of instruments; the microscopes that began to be made soon after started the equally important observation of fine structure which has now become the chief preoccupation of modern science. Every branch of science seeks first an accurate description of the gross appearance and behaviour of its segment of Nature; and this has customarily been followed by the attempt to analyse the matter that is present into its components and to ascertain significant relations between these components and the gross properties with which the original description was so largely concerned. In chemistry, this analysis has been achieved through the interpretation and correlation of elaborate series of chemical reactions. For certain other sciences, the microscope has been a much more direct analytical tool. Thus, the analytical stage for biology may be said to have begun when compound microscopes made accessible for study the individual cells that are the unit structures of living matter.

Since then, there has been a steady improvement in techniques of microscopy which, though providing very little extension in vision, have yielded a steady flow of new knowledge about the cellular level of organization. In our day, the electron microscope is of such exceptional importance because it does give such an extension, and one that allows us not merely to see smaller detail but also to reach in biology the deeper and more fundamental level of organization where molecules are the units. For the past twenty-five years we have known that the proteins and many other substances extracted from living matter have very large molecular particles. A number of these particles have already been seen under the electron microscope, and the fact of this visibility takes us beyond chemistry's conventional concern with statistical molecular aggregates to observations on separate molecules and their interactions. It is the principal object of this discourse to illustrate some of the more immediate applications we have made of this ability to see macromolecules.

Before doing this, however, I must give some idea of the great extension in vision already achieved with this new microscope. The limiting resolving power of any optical system defines its ability to portray small objects: it depends on the wave-length of the illumination we use. Optical theory has demonstrated that no microscope can possibly reveal the true shape of an object smaller than about half this wave-length. Accordingly, visible light cannot delineate objects smaller than *c.* 0·2 micron (about a hundred-thousandth of an inch); with ultra-violet light we can do little better. Electron microscopes, though only about fifteen years old as scientific instruments, have already portrayed objects more than a hundred times smaller than this in linear dimensions and hence more than a million times smaller in volume and weight. Such tiny particles are only five to ten atoms across. The newly visible world having such relatively small molecules as its lower limit is about as extensive, and as full of unknown things, as that aspect of Nature which the optical microscope first brought to light. It will take a long time to discern all that is here, and still longer fully to understand what we are seeing. In the meantime, we have all the excitement of seeing what no man expected to see, and of using much of the new knowledge thus gained to approach with clearer understanding many of biology's essential problems.

An indication of the relationship of the electron microscope to the familiar optical microscope may help in interpreting the images it produces. Seventy-five years ago, in 1879, Sir William Crookes demonstrated in the Royal Institution various forms of his new cathode-ray tube. The electron microscope is such a tube in greatly elaborated form. Like the Crookes tube, it has a source of electrons and a fluorescent screen to show their pattern; a magnetic field is commonly used to change their direction. In the electron microscope there are several of these fields, and they are so arranged that the electrons follow paths through the tube that imitate the path of light through the glass lenses of an optical microscope.

From a consideration of what an electron microscope is, it will be realized that there is no compelling technical reason why we should not have had some

* Substance of a Friday Evening Discourse at the Royal Institution delivered on December 11. The Discourse was illustrated by a series of electron micrographs from among which the accompanying figures were taken; an electron microscope was also demonstrated and its images shown to the audience on several television receivers. This demonstration was arranged through the courtesy of Philips Electrical, Ltd., and E. M. Industries, Ltd.

Fig. 1. Early stage in the crystallization of a necrosis virus protein. The orderly arrangement of the particles is apparent. × 40,000

form of this instrument many years ago. Probably it was not built because its advantages become obvious only when our realization of the wave qualities of the electron started people thinking about it as an illuminant. Here is, in fact, a rather striking example of how our scientific imaginations may be bound by the ideas current at any time.

In science, as in most other fields of human endeavour, we rarely get everything we would like, and accordingly, it should not be a surprise that there are important limitations to what can be looked at under an electron microscope. For the most part these arise from the relative impenetrability of matter by electrons; therefore, the object must be extremely thin and, after thorough drying, it must be examined under the vacuum of the tube. This is not an overwhelming disadvantage; but it makes necessary new methods of specimen preparation that will preserve the structures we are interested in, down to their finest molecular details.

To delineate very small objects we must look at their very highly magnified images; this involves magnifications far greater than those useful in optical microscopy. The detail seen in the best optical microscopes becomes increasingly 'fuzzy', indistinct and meaningless when viewed at magnifications above about 1,500 ×; but we can now have electron micrographs in which detail is sharp at 150,000 ×. Occasional electron micrographs are worth studying at twice this magnification. These magnifications are so vastly in excess of any in our previous experience that most of us find it difficult to have a vivid realization of how very small are the objects we are seeing.

Many novel problems arise when we use the electron microscope to see molecular particles. In it, objects are visible by reason of the electrons they deflect, or scatter; and a molecular particle is able to deflect very few compared with the substrate that must be used to support it. This lack of a necessary contrast in the resulting image can be met by evaporating a few atoms' thickness of heavy metal obliquely over a preparation. Then contrast is enhanced by the little atomic shadows cast by molecular and other detail, and these have the added advantage of giving the image a three-dimensional quality that reveals the shapes of what we see.

There is one very important difference between the practice of optical and of electron microscopy, made necessary by the destructive effects of powerful electron beams. In general, the optical microscopist does most of his work visually and only occasionally takes a picture. The electron microscopist, on the contrary, uses visual images mainly to find and to focus on fields of interest. By then taking pictures on fine-grained photographic film and enlarging them later, he is able to obtain very high useful magnifications without employing the destructive electron intensities that would be needed to give bright images at these highest enlargements.

It is impossible to do more here than show what a few typical macromolecular particles are like, and indicate some of the problems dealing with them that are now claiming our attention. In essence these problems are threefold. They involve recognizing and measuring the particles, determining how they are arranged in the structures they form, and trying to find out how they are produced in Nature.

The proteins that occur in solution in a living organism offer many examples of approximately spherical macromolecules. When sufficiently purified, these substances often crystallize well, and we can study with the electron microscope various stages in

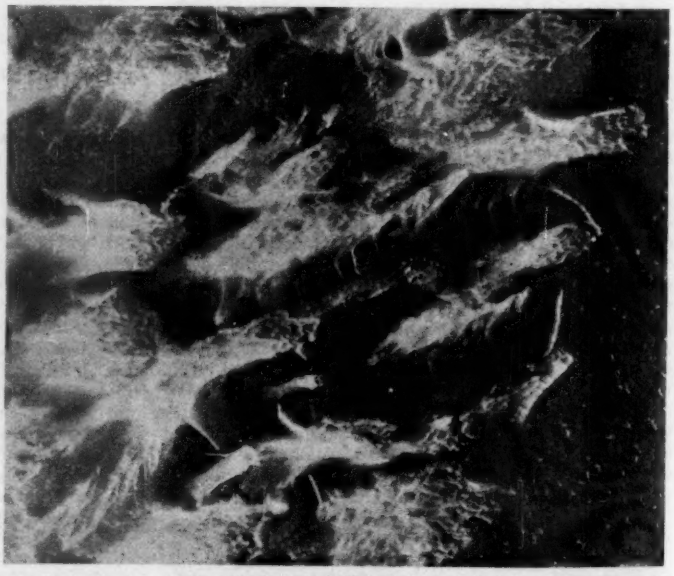

Fig. 2. Section through a swollen tendon. Two or three unswelled fragments show their 650-A. striations. × 21,000

the growth of the single crystals they form. The photographs that have been obtained from a number of proteins and plant virus proteins show the beautiful molecular order that characterizes all steps in crystal formation (Fig. 1).

Another highly important type of molecular particle is a long filament. The thicker among these are relatively stiff and straight, like the tobacco mosaic filaments in old solutions or the elementary particles of cellulose. Those that are thinner are wavy threads. Solutions of the muscle proteins, of collagen from connective tissue and of the nucleic acids contain such threads; some that have been photographed are less than ten atoms in diameter. Paracrystalline, rather than crystalline, solids composed of these filamentous macromolecules are among the important framework structures of plants and animals. Their investigation is one of the most rewarding of the current applications of electron microscopy. Filaments display a striking tendency to assume parallel arrays. Thus, the secondary walls of plants consist of stacked sheets of parallel aligned filaments of cellulose. Striated muscle has a parallel alignment of molecular threads as a sort of backbone for its other components. Sections cut at right angles to a muscle fibre demonstrate many fine details of an ordered packing of these threads that in some places is almost crystalline in its perfection. Evidently the kind of knowledge that will result from such observations permits an entirely new approach to the problem of muscular contraction.

An equally good but very different type of molecular order prevails in tendon and other forms of connective tissue. Collagen, for example as Achilles tendon from the heel, has been examined as shredded fragments and in sections cut in various directions through an intact tendon. At low magnifications not much above those used in optical microscopy, one sees the tiny fibrils that are associated together in bundles and sheets to form the macroscopic tendons. Higher magnifications reveal the fine structure of each component fibril. The examination of transverse sections suggests that a fibril is enveloped by a tube of collagen; preliminary swelling shreds the collagen and shows how its macromolecular particles are knitted together to produce such a tube (Fig. 2). Collagen dissolves in very dilute acids and alkalis and can be re-precipitated from its solutions. The electron microscope demonstrates that under certain conditions these re-formed fibrils have the molecular fine structure of the original collagen, but that under other conditions of precipitation fibrils of different fine structures are produced. Some of these are found in Nature, others are not. Such investigations of the various forms of collagen are important, not only for their bearing on the nature of paracrystalline order, but also because they permit us to study the changes in connective tissue that accompany and perhaps may sometimes be responsible for arthritis, rheumatism and similar degenerative diseases of man.

When we seek to deal with the third broad field of study opened up by electron microscopy—how these macromolecular particles arise—we immediately realize the need first for an adequate picture of the fine structure of the living cells that produce them. Most of what we know about the cells that constitute the higher plants and animals has been gained from optical microscopic studies on thin sections of their tissues. To extend our observations to electron microscopic magnifications it has been necessary to learn how to cut sections that are about fifty times thinner than those required for this optical work. Such wafers of tissue only a few millionths of an inch thick can now be cut as a matter of routine. With them we are beginning to survey again some of bacteriology and many problems of histology and embryology from the point of view of the new detail that is to be seen. Artefacts formed during specimen preparation obviously are more troublesome the finer the structures being studied, and new methods must be developed before we can utilize to the full the potentialities of the electron microscope. Nevertheless, the progress already made has revealed far more than we can yet interpret within sectioned tissues.

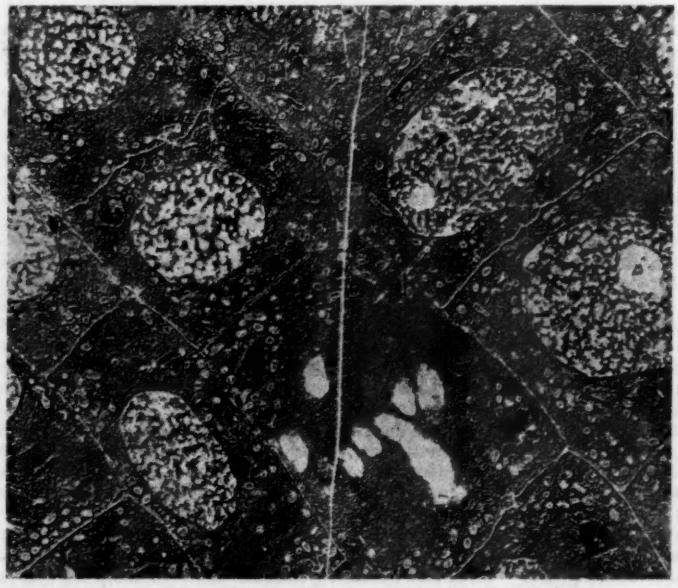

Fig. 3. Section through an onion root tip showing parts of several resting and one dividing cell with its (sectioned) chromosomes. × 7,300

Innumerable questions can be answered from the examination of healthy cells. If they are from plants we can, for example, follow the growth of their walls and we can examine the fine structure of their chloroplasts, of their starch grains and of the many other objects to be seen in their cytoplasm. If they are of animal origin, we can inquire into the elaborate mitochondrial and other structures that are particularly striking in cells of special function such as those in the liver or kidney, in the eye or the nervous system. With both plant and animal cells we can approach from this finer level of organization the mechanism of cell division (Fig. 3).

These studies of components of the normal cell and of how they develop supply the background

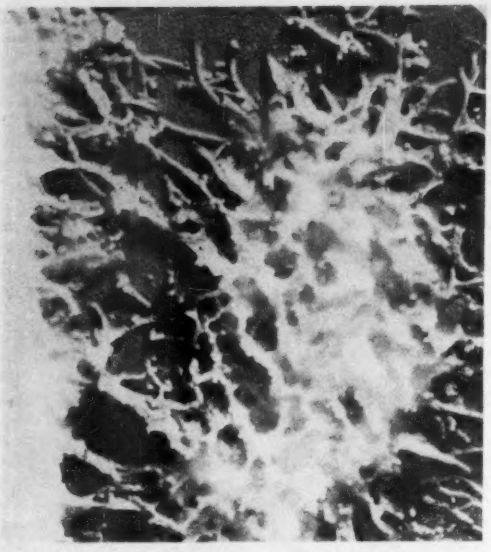

Fig. 4. A mass of influenza virus particles developed from a cell, the border of which appears along the left edge of the photograph. × 8,200

requisite for investigating the abnormalities of cell life that are responsible for many diseases of living matter. Virus diseases are among the first of these to which we naturally turn, both because the viruses that cause them are too small to have been visible before and because, whatever their nature, these pathogenic agents stand on the borderline between the animate and inanimate and thus offer a unique opportunity of learning more about the essence of the living state.

My laboratory in the United States at the National Institutes of Health has been particularly concerned over the past few years with this study of virus growth, and we have learned much about how several viruses develop within the cells that are their hosts. There appears to be no uniform pattern for this development, and one cannot briefly describe the various types of virus growth we have seen. Nevertheless, I would like in conclusion to indicate what we have found about one familiar virus—that of influenza. From an examination of purified suspensions, we know that its infectious particles are either tiny spheres or filaments of the same diameter. In sections through diseased tissues we find these virus particles not within the infected cells themselves, as many of us would have expected, but clustered around their peripheries and developing from them as filaments that break off and segment into spheres (Fig. 4). Such observations with the electron microscope demonstrate that the elementary infectious units of this virus have not proliferated after the fashion of minute micro-organisms but instead are bits of cytoplasm of the diseased cells.

The particles of several other viruses, including bacteriophages, are derived from the protoplasm of the host cells; but there are other viruses that do not have such an origin. Some appear to arise from specialized components of the diseased cell, whereas others may be foreign invaders that multiply like micro-organisms, by growth and division. Much more observation is needed before the full story of virus growth is known; but it is important that we at last have a method capable of giving this knowledge.

At this early stage in our explorations with the electron microscope it is not possible to foresee what new insights into the vital process it will next give us. Perhaps they will come as we address ourselves more and more towards the small viruses, especially those that attack nervous tissue; or perhaps we shall find more immediately rewarding the closer study of the numerous structures that are steadily being found as we examine a widening range of healthy cells. Whichever it is, we may be sure that our visual penetration of the macromolecular level of organization will prove steadily more fruitful as experience gives us an increasing ability to interpret the new things we observe.

CENTRAL LABORATORIES FOR SCIENTIFIC AND INDUSTRIAL RESEARCH, HYDERABAD

Opening Ceremony

THE new buildings of the Central Laboratories for Scientific and Industrial Research, Hyderabad, were opened by Shri Jawaharlal Nehru on January 2, in the presence of distinguished guests, foreign scientists, delegates to the Indian Science Congress and eminent industrialists.

Rashtrapati Rajendra Prasad sent a special message for the occasion, conveying his best wishes for the successful fruition of the endeavour made by the State for the advance of science. He further stated that: "It goes without saying that money spent on research is rightly regarded by all progressive nations as a sound investment made for the common weal. Attempts like these, therefore, deserve all encouragement that the State could give in the interest of human progress and happiness. I congratulate Hyderabad State for establishing these laboratories and fervently hope that those who would have the privilege of working in these laboratories would be inspired by the lofty ideal of rendering service to humanity".

Dr. Husain Zaheer, director of the Central Laboratories for Scientific and Industrial Research, in his address emphasized the importance of regional laboratories working in co-operation with the national laboratories for the overall development of scientific and industrial research in India. The immediate and early exploitation of new inventions, he said, requires a degree of technical skill and finance which is usually not available even in countries like Britain, with the result that a great majority of such discoveries made during the past twenty years were first exploited in the United States. He therefore emphasized that the main activities of the laboratories, at least for some time to come, will be directed not so much towards making new discoveries or inventions as towards developing and adapting already known methods and techniques. Consequently, the work in the Laboratories has been concentrated on developmental work of modern methods and on adapting them to the industrial needs and requirements of this region.

The Prime Minister, Shri Jawaharlal Nehru, in his speech referred to the scientific progress the world has made during the past few years; he said that science has changed the whole world, and this must be accepted by India. While the people in India had begun to realize the importance of science, he believes that there are still many who do not realize the necessity or importance of scientific research. He added that, despite able administration, no country can progress without science; scientists and engineers are far more important than administrators. The administrators have, no doubt, their place, but it is secondary to that of scientists and engineers. It is therefore necessary that scientific research should make progress in India.

Dealing with the division of work among the various laboratories, the Prime Minister said that, for a big country like India, both general and special laboratories are necessary. It is desirable to have the laboratories spread out in different regions so that the scientific outlook should become familiar throughout the country. But, he said, there should be no waste of energy in regard to the work done by these laboratories. One individual or institution cannot do everything thoroughly and efficiently; the standard of work must be maintained at a high level. Duplication of work may sometimes be necessary, but there must be no waste. Mr. Nehru felt that a general laboratory for the south of India was appropriately sited in Hyderabad, and hoped that the work there would contribute to the progress and prosperity of this region as well as of the whole country.

After the buildings of the Laboratories were declared open, the Prime Minister and distinguished guests inspected them and also the cotton-seed processing pilot plant and the pilot plant for the low-temperature carbonization of coal.

General Aims of the Laboratories

The Laboratories were established in 1944 by the Hyderabad Government on the initiative of the Council of Scientific and Industrial Research. But due to unsettled political conditions in the State, the full plan could not be carried out immediately. Dr. S. Husain Zaheer took charge of the Laboratories as director in November 1948, and submitted a detailed scheme for their organization and development to the governing body. He laid emphasis on developmental and pilot-plant research utilizing the raw materials of the State. The scheme was approved by the governing body in March 1949. The then Military Government took an active interest in the implementation of the plan. Extensive lands were acquired near the Osmania University campus. The foundation stone of the new buildings of the Laboratories was laid by Major-General J. N. Chaudhuri, Military Governor of the State, on November 6, 1949.

The main building is in the shape of a T, with administrative block, the auditorium and the museum forming the two wings and the laboratories forming the central block, which consists of a basement and four floors. The ancillary buildings consist of four large pilot-plant buildings, workshop, electricity sub-station and the gas house.

The first stage, which has been completed, consists of a basement, ground floor (excluding auditorium and museum), first floor, two pilot-plant buildings, workshop, electricity sub-station, gas house and store house for inflammable chemicals, with a total floor area of 86,000 sq. ft. The total expenditure on buildings has so far been Rs. 21 lakhs. Approximately Rs. 30 lakhs has been spent up to now on pilot plants, equipment and apparatus, etc.

The main purpose of the Laboratories is to carry out developmental research of an industrial nature covering the fundamental as well as applied aspects of each problem. Research problems taken up for investigation are initially put forward by research committees, government departments or industries, or are brought up during discussion between the director and research workers. The problem is discussed in detail in the Operational Research Unit and a decision taken regarding its importance and feasibility. Afterwards, information relating to the availability of raw materials, demand for finished products, their market prices, etc., is collected and a 'literature note' is prepared incorporating all the data available. This note is discussed anew by the Operational Research Unit and a detailed programme of work with a time target is drawn up. On successful completion of the laboratory investigation, the Pilot Plant Committee studies the chemical engineering aspects of the problem concerned in its translation to the pilot-plant stage, and prepares a non-technical note with approximate costings, for circulation among interested industries. Pilot-plant experiments are then undertaken either in the Laboratories or by industries, and an industrial process is evolved on the basis of these trials. The pilot-plant schemes are also sent to the various specialized bodies of the Government of India, like the Indian Central Oilseeds Committee, the Council of Scientific and Industrial Research, the National Research Development Corporation and others.

In the selection of the research programme, every effort is made at all stages to co-ordinate the work with that of the National Laboratories, and care is taken to avoid unnecessary duplication of effort.

Work of the Sections

The *Fuel Section* has concentrated mainly on a detailed study of all aspects of the utilization of the rich and extensive deposits of coal in Hyderabad State. A detailed survey of the coal deposits has been under way during the past three years. Recently, the Council of Scientific and Industrial Research, Delhi, has entrusted these Laboratories with similar work on the available deposits of lignite coal in Madras State. Washability tests on coal of high ash content are regularly carried out in a modern type of heavy-medium separation plant on a semi-large scale. The Tatas are interested in the washability tests of coal and have requested the Laboratories to carry out similar tests on coal from Digwadih (Bihar). A 25-ton/day plant employing the Lurgi process of low-temperature carbonization of coal, the first of its kind in India, has been erected and is in operation for testing non-caking coal of this State as well as similar coal and lignite from other parts of the country. Problems connected with the low-temperature carbonization of coal, such as study of tar, ammoniacal liquor, and recovery of tar acids, benzole, etc., are under investigation. It is proposed to set up, shortly, experimental units for tar hydrogenation and pressure gasification.

The *Heavy Chemicals Section* has, in view of the sulphur shortage in the country, carried out considerable work on sulphates as an alternative source of sulphur. Work on the utilization of the limited deposits of iron pyrites for the same purpose has also been actively pursued. Work on the preparation

of activated carbon from groundnut hulls, potassic fertilizers, activated silica and white cement from felspar, and phosphatic fertilizers from bone meal have given encouraging results.

The *Ceramic Section* has aimed at the utilization of indigenous raw materials. Systematic studies of Hyderabad clays, including X-ray and base-exchange studies, have been carried out. The methods of manufacture of sand-lime and clinker-lime bricks, insulator bodies, insulator bricks, whiteware bodies and fire-clay refractories have been investigated.

The *Physical Chemistry and X-ray Section* has carried out valuable X-ray studies on the nature of Hyderabad clays and is at present engaged in X-ray studies of other clays and of monazite sand. The section is equipped with modern types of instruments such as ultra-violet spectrographs, petrological microscope, metallographic equipment, etc.

The *Oils Section* has been engaged in extensive studies on sitaphal seed; on cotton-seed (storage of seed, composition of seed and oil, refining of oil and utilization of foots), and on castor oil (detailed investigations on dehydration, isolation of the valuable lubricant triricinolein). Katha (acacatechin) has been found to be an excellent anti-oxidant for edible oils. Methods of fractional separation of fatty acids using urea adducts have been extensively investigated. Several local fuller's earths and clays have shown valuable bleaching properties, and large-scale trials are in progress.

The *Biochemistry Section* has carried out extensive studies on the utilization of molasses, and has aimed at the production of citric acid (using strains of *Aspergillus niger*), lactic acid and calcium lactate, food yeast, and lævulinic acid and its salts. Selected strains of *Aspergillus terreus* have been employed for the production of itaconic acid from glucose and sucrose. The protein and non-protein nitrogenous constituents of the seed cake of *Annona squamosa* are also being investigated.

The *Organic Chemistry, Pharmaceuticals and Drugs Section* is working on both natural and synthetic products. Quinazoline-type compounds with potential analgesic activity have been prepared, a new synthesis of pethidine attempted and encouraging results have been obtained in a scheme for the simpler synthesis of diethylstilbœstrol. Studies have been carried out on the preparation of strychnine from nux vomica. The fundamental constituents of Indian turpentine are being re-investigated, while chlorinated turpentines have shown outstanding insecticidal activity. The preparation of vanillin from the lignin obtained from paper-mill black liquor has been attempted, and pure geraniol has been prepared from palmarosa oil.

The *Paper and Fibre Section* has been investigating the production of hand-made paper for different purposes, for example, bond, drawing, writing and filter papers, utilizing locally available raw materials. In view of the existence of an acetate–rayon factory in the State, this section has been actively investigating the various cellulosic materials as raw materials for rayon manufacture.

The *Entomology Section* has been testing the insecticidal efficiency of various products prepared in the Laboratories.

The *Chemical Engineering Section* is associated with all pilot-plant schemes of the Laboratories and with the procurement and setting up of equipment. The section has been carrying out extensive studies on solvent extraction of oil-cakes. It also advises the regional industries in their chemical engineering problems, in addition to helping them in the erection and operation of their manufacturing plants. It has been responsible for erecting the Lurgi plant for low-temperature carbonization of coal and a complete Carver pilot-plant for pretreatment of cotton-seed. The chemical engineering aspects of processes worked out in the Laboratories, such as production of lævulinic acid from molasses, of fructose from cane sugar, of itaconic acid from sucrose, of dehydrated castor oil, briquetting of coal, fluidization of coal, fractionation of fusel oil, hand-made paper, refining of palmarosa oil, activation of Hyderabad earths, etc., have been engaging the attention of this section.

The staff comprises the director of the Laboratories (Dr. S. Husain Zaheer), two assistant directors (Dr. S. A. Saletore, one vacancy), 53 scientific officers and research assistants and 52 technical staff.

Reports and Finance

During the years 1950–53, fifty-three papers were published by the Laboratories staff, twelve were communicated for publication, 187 papers were read at various symposia and conferences, seventeen patents were obtained and two patents are pending grant.

The Laboratories organized symposia on fuels, fats and oils and on research and industry in 1950, and later published the proceedings.

Annual reports (since 1950) are published regularly, giving summaries of the items of work under investigation.

The Laboratories strive to maintain close relations with other research institutions in India and abroad, and with industries. Regular visits by members of the staff are paid to various factories; for example, to the Nizam sugar factory, Sirpur paper mills, Sirpur acetate–rayon plant, Singareni collieries, ceramic and glass factories, vegetable oil factories, chemical and biochemical manufactories. Advice is given on both short-term and long-term problems.

The recurring budget of the Laboratories for 1947–48 stood at Rs. 2·74 lakhs; for 1953–54 it is Rs. 4·5 lakhs.

The non-recurring grants actually made available over the past five years include the following:

	Rs.
(*a*) Building	
From the Government of Hyderabad	16·7 lakhs
From the Government of India	5·0 ,,
(*b*) Equipment	
From the Government of Hyderabad	7·1 ,,
(*c*) Pilot-plant projects	
Grants from the Industrial Trust Fund, Hyderabad	
Low-temperature carbonization plant	7·5 ,,
Chemical engineering equipment	2·6 ,,
Cotton-seed processing plant	1·0 ,,
(*d*) Research schemes	
Coal survey	
Grants from the I.T.F., Hyderabad	12,000
Grant from the C.S.I.R., Delhi	22,000
X-ray studies on Indian clays	
Grant from the C.S.I.R., Delhi	6,000
Grant from the Atomic Energy Commission	5,000
Briquetting of non-caking coals	
Grant from the C.S.I.R., Delhi	7,000

A sum of Rs. 1 lakh was given to the Laboratories in 1953 by the Azamjahi and Osmanshahi Mills, Ltd., Hyderabad. This was further augmented by smaller donations of a total value of Rs. 15,800 from other industries. The interest from these sums is being used for instituting research scholarships. Under the five-year plan Rs. 27 lakhs have been sanctioned to the Laboratories but have not yet been made available.

OBITUARIES

Prof. A. G. Ogilvie, O.B.E.

THE sudden death of Alan Grant Ogilvie, who collapsed while attending a meeting of the Royal Scottish Geographical Society on the evening of February 9, takes from our midst one of the few remaining pioneers of the new geography as a university discipline. Born in Edinburgh in 1887, he maintained throughout his life much of the dignity and Victorian charm characterizing his childhood home—the son of a distinguished if austere father, the late Sir Francis Ogilvie. From George Watson's College and Westminster School, he proceeded to Magdalen College, Oxford, taking his B.A. in 1909. Periods of study at the Geographical Institute of the University of Berlin and at the Sorbonne followed, and gave him a command of European languages and a wide range of academic contacts—further extended by geological studies at the Imperial College of Science and Technology, London.

His academic career began in 1912 when he was appointed junior demonstrator in geography at Oxford but was interrupted by the outbreak of war in 1914. Ogilvie had accepted a commission in the 7th London Brigade of the R.F.A. in 1911, so he was immediately called up and served in France, the Dardanelles and Salonika before becoming staff captain at the War Office in 1918. His selection as leader of the Geographical Section of the British Peace Delegation at Versailles was an obvious one. It was there that he began a lasting friendship with Isaiah Bowman, leader of the American Geographical Section. It was often difficult for the few experts present to hide the sometimes abysmal ignorance of the peace-makers concerning the countries and peoples for whom they were legislating. There is no doubt that the state of affairs thus revealed stimulated the establishment of Honours Schools of Geography in most British universities in the decade which followed. Ogilvie was made O.B.E. for his services and was appointed reader in geography at Manchester. The following year, however, Bowman, then director of the American Geographical Society, invited him to New York, and during 1920–23 he was head of the Hispanic American Division of the Society. There he showed his flair for collating work from many and varied sources, evidenced first by his "Geography of the Central Andes" (1922). In 1923 he returned to his native Edinburgh, there to spend the rest of his life, first as lecturer, then as reader (1924) and finally as professor of geography from 1931 until his death.

Ogilvie's writings were neither numerous nor voluminous, but always scholarly and showing evidence of very wide reading. His work as editor and part author of "Great Britain", a series of regional essays prepared for the International Geographical Congress in 1928, remains of lasting value. He served devotedly the Royal Scottish Geographical Society (honorary secretary, 1925–41; president, 1946–50) as well as the British Association (president, Section E, 1934; chairman of Committee on Tropical Africa), the Institute of British Geographers (president, 1951–52) and the International Geographical Union (section president, Lisbon, 1949).

A man of great intellectual integrity himself and not always robust physically, he refused to condone lower standards in others, and perhaps envied the greater facilities for field-work and research enjoyed by the younger academic men of to-day. To them he sometimes appeared austere and even intolerant, but many grew later to know him as a sincere friend. His solid Edinburgh home meant much to him, and he felt very deeply the recent loss of his wife after a trying illness. He himself will be greatly missed.

L. DUDLEY STAMP

Mr. David Milne, C.I.E.

MR. DAVID MILNE, who died recently, was one of the fast-dwindling members of the Indian Agricultural Service, which was started about 1903 and the members of which by their devoted labours did so much to improve agriculture in India and from which she is now reaping the benefit.

Born in Scotland in 1876, Milne was educated in the University of Aberdeen, where he took his degree in science. His first appointment was to Egypt, where he was agricultural chemist to the Corporation of West Egypt, and when, no doubt, he made his first contact with cotton, a crop with which he was intimately concerned for the remainder of his career.

In 1907 he joined the Indian Agricultural Service and was posted to the Punjab as economic botanist, a post he held until 1921, when he became principal of the Lyallpur Agricultural College. In 1922, however, he was promoted to be director of agriculture, Punjab, and held this important post until his retirement in 1933, being made C.I.E.

The name of Milne will long be remembered in the Punjab and India for his work in selecting new types of long-staple cotton. The climate of the irrigated areas of the Punjab present certain peculiarities, and the type of plant has to be selected to meet these conditions. After the First World War, there was a shortage of long-staple cotton, and the demand for cotton of the Middling American standard, and even a little longer in staple, was strong both from the Bombay mills as well as from Lancashire. Prior to his arrival, attempts to introduce seed direct from the United States had met with little success, for these varieties failed to thrive under Punjab conditions, and although they obtained a premium on quality, they failed to find popular favour because their yields were very much smaller than the short-stapled Deshi, a native Indian type. By applying modern methods of plant breeding, Milne evolved new varieties of American upland-type cotton which not only withstood jassid and other pests but also gave yields approximating to those given by the native types. The first of these cottons was a variety called 4 F, and it was replaced by a variety with a somewhat longer staple, 284 F, and other selections followed. As a result of his work, American upland cottons of long staple came to be cultivated over very large areas in the Punjab and Sind and did much to meet the demand of the Indian mills.

Although most of his scientific work was applied to cotton, he found time to study other crops as well, and made a detailed study of the possibilities of cultivation of date palm in the Punjab. His "Handbook of Field and Garden Crops in the Punjab" also proved of great value in teaching establishments.

Milne became a member of the Indian Central Cotton Committee and was also on the Council for Agricultural Research in India from 1928 until his retirement in 1933.

G. EVANS

NEWS and VIEWS

Chemistry at King's College, Newcastle upon Tyne (University of Durham):

Prof. W. F. K. Wynne-Jones

On the retirement of Prof. G. R. Clemo, who has been director of the Chemical Laboratories at King's College, Newcastle upon Tyne, since 1932, Prof. W. F. K. Wynne-Jones becomes professor of chemistry and head of the Chemistry Department. Prof. Wynne-Jones, who was appointed to the chair of physical chemistry in the College in 1947, has carried out distinguished work in the field of chemical kinetics (see *Nature*, **160**, 291 ; 1947).

Organic Chemistry : Prof. G. R. Clemo, F.R.S.

Prof. G. R. Clemo retires at the end of this session from the chair of organic chemistry at King's College, Newcastle upon Tyne, which he has occupied since 1925. Clemo received his early training at University College, Exeter, and, after a period as science master at Penzance, he went to the Queen's College, Oxford, to work under Dr. Chattaway. His experimental skill was used to the full during the First World War, when he worked in a team under Prof. W. H. Perkin on the synthesis of dyestuffs which were urgently needed because the industry had been allowed to lapse in Britain, whereas it was extensively developed in Germany. In the years immediately following the War he continued to work under Perkin and was a well-known figure in the Dyson Perrins Laboratories at Oxford. In 1924 Clemo was appointed director of the research laboratories of the British Dyestuffs Corporation at Manchester, a post which he relinquished on his appointment to the chair of organic chemistry at Armstrong College (now King's College, Newcastle upon Tyne). His tenure of the chair has been marked by considerable productivity and by the growth of the Department to its present high position in the chemical world. Clemo in his own work has been an outstanding disciple of Baeyer and Perkin, and, while his interests have ranged over the whole field of natural products, he has contributed particularly to an understanding of the lupin alkaloids. He and his associates have also synthesized anti-malarials related to quinine, and in recent years Clemo has been studying the little-known alkaloid tazettine isolated from snowdrops, and has directed his attention to the widespread black pigment, melanin. Throughout his career Clemo has been devoted to the laboratory bench, and has set an example of personal industry which has stimulated his associates.

Prof. F. S. Spring, F.R.S.

Prof. F. S. Spring, who is to succeed Prof. Clemo, was educated at Waterloo Grammar School and in the University of Liverpool, where he began research work under Prof. I. M. Heilbron. In 1930 Spring went as assistant lecturer to the University of Manchester, and had attained the position of senior lecturer when he left in 1946 on his appointment as Freeland professor of chemistry in the Royal Technical College, Glasgow. In his association with Prof. Heilbron as pupil and collaborator, Spring carried out an extensive and an impressive study of the chemistry of the sterols. Since going to Glasgow, he has built up a flourishing school of organic chemistry which has made important contributions to the chemistry of the steroid and triterpenoid groups of chemical substances. In this study they have succeeded in isolating triterpenoids of unusual structure from *Strychnos nux-vomica* and from opium. Spring's work has led him to close association with the medical aspects of organic chemistry, and he has been investigating possibilities in the synthesis of cortisone as well as the possible relationship of steroid metabolism to arthritis. Spring has shown himself a master of experimental method and an original investigator : his enthusiasm and energy combined with his clear insight into problems of organic chemistry ensure that the development of this subject will continue in Newcastle.

Directorship of the Bermuda Biological Station : Dr. L. W. Hutchins

Dr. Louis W. Hutchins has been forced by ill-health to retire from the directorship of the Bermuda Biological Station, in which capacity he has served since 1949. Dr. Hutchins is a graduate of Yale University, receiving his doctorate in zoology in 1941, and was Mary S. Muellhaupt Scholar at Ohio State University during 1941–42. He then became associated with the Woods Hole Oceanographic Institution in connexion with investigations being made for the United States Navy on the prevention of marine fouling, and he contributed several chapters to a monograph on "The Prevention of Marine Fouling", prepared by the Woods Hole Oceanographic Institution for the Navy. Dr. Hutchins is a specialist on the salt-water Bryozoa and has made important contributions to the interpretation of temperature zonation in geographical distribution. He is now an associate on the staff of the Woods Hole Oceanographic Institution.

The Bermuda Station was founded in 1901 by Dr. E. L. Mark, of Harvard University, for the scientific study of biology. When it was reorganized and incorporated in 1931, it received an endowment from the Rockefeller Foundation to permit it to function also as an oceanographic station, for which its location is admirable. Dr. Hutchins was well fitted to develop this part of its activities, and he immediately initiated a general oceanographic programme for working out the economy of the waters inside the fringing reefs and their relationships with the ocean water outside.

Dr. W. H. Sutcliffe, jun.

Dr. William H. Sutcliffe, jun., who has been appointed to succeed Dr. Hutchins at the Bermuda Biological Station, has served as staff biologist at the Station since 1951 and is consequently well acquainted with the local situation and the fauna of the islands. A native of Florida, he was educated at Emory University and at Duke University, where he was granted his doctor's degree in 1950 for studies in marine ecology. Prior to going to Bermuda, he worked at the Institute of Fisheries Research of the University of North Carolina, where he conducted research on zooplankton and on the commercially important shrimp of Carolina waters. At Bermuda he has been investigating the biology of the spiny lobster, *Panulirus guttatus*, on behalf of the Bermudan Government. He has published papers on the taxonomy of the calanoid copepods of North Carolina waters and on the breeding and migration of the spiny lobster. Dr. Sutcliffe brings to his task as director experience in the application of oceanography to fishery problems. His pre-

decessor organized an oceanic fisheries conference in Bermuda during 1951, at which the prospects for taking fish from the open and deep ocean—a difficult problem—were explored. An outcome of this was the provision by the Bermudan Government of a research vessel for ocean work, which should enable valuable fishery investigations to be undertaken.

Institution of Civil Engineers' Secretaryship: Mr. E. Graham Clark, C.B.E.

WHEN he retires this year on reaching the age of sixty-five, Mr. E. Graham Clark, secretary of the Institution of Civil Engineers, will have completed thirty-five years on the permanent staff of the Institution. A graduate of the University of Durham, he had spent four years as a pupil and assistant engineer before the First World War took him into the 50th (Northumbrian) Division, Territorial Forces. He was awarded the Military Cross, and on his return home in 1919 joined the staff of the Institution of Civil Engineers as chief technical assistant. He later became chief assistant to the secretary, Dr. H. H. Jeffcott. After a period as acting secretary in 1937, Mr. Clark was chosen to succeed him. Only those who have worked closely with Mr. Clark know how loyally and enthusiastically he has striven to advance the prestige and usefulness of the Institution. He leaves an Institution which has greatly developed in character and influence during his years of office. Before his time, there were no special divisions of the Institution, no Colonial Engineering Conference and no international associations of engineering societies. The local associations and the associate members of the Institution were not represented on the Council. Institution meetings were relatively few and the publications far less comprehensive than to-day. The bringing together of the three major engineering institutions of Britain, the Civils, the Mechanicals and the Electricals, to work in close collaboration has been one of Mr. Clark's noteworthy achievements. This *rapprochement* was soon followed by the formation of the Conference of Representatives from the Engineering Societies of Western Europe and the United States of America and the Conference of Engineering Institutions of the British Commonwealth. He has played a leading part both in their inception and in the conduct of their business. Mr. Clark was honoured for his services to engineering by being created C.B.E. in 1948, and by the award of an honorary M.Sc. of the University of Durham in 1953.

Mr. Alexander McDonald

IN succeeding Mr. Graham Clark as secretary of the Institution of Civil Engineers, Mr. Alexander McDonald will be undertaking a task which has no equal in service to the civil engineering profession. A graduate of the University of Edinburgh, he entered the Nigerian Engineering Service after practical training in Britain. At the age of fifty, Mr. McDonald has completed more than twenty-five years service in Nigeria and has risen to become the Inspector-General of Works—the head of the Public Works Department—a post which he has held with distinction during the past three years of active political change in that country. He brings to his new task a wide and varied experience of civil engineering ranging from water supply to airfield construction, and has studied highway engineering in the United States. He has contributed two papers to the Institution. He has always shown a keen interest in the affairs of the Institution, and it was to satisfy his desire for the Institution to play a greater part in the life of the Colonial engineer that the Colonial Engineering Conference, now held biennially, was instituted; he was also the moving spirit in forming the West African Joint Branch of the three Institutions and is its first chairman.

Verband Deutscher Physikalischer Gesellschaften

WITH the close of hostilities in 1945 the Deutsche Physikalische Gesellschaft and the Deutsche Gesellschaft für Technische Physik ceased to function; later, in their place, there was founded the Verband Deutscher Physikalischer Gesellschaften, made up of the following five organizations: Physikalische Gesellschaft in Bayern, Physikalische Gesellschaft zu Berlin, Physikalische Gesellschaft Hessen-Mittelrhein, Nordwestdeutsche Physikalische Gesellschaft, and Physikalische Gesellschaft in Württemberg-Baden-Pfalz. At a meeting of the Verband in Innsbruck last September it was decided that amends should be made to all former members of the two original German physical societies whose names were removed, for political or other reasons, from the societies' rolls. There are many such persons, mostly living outside Germany, and an attempt has been made to get into touch with each one by letter and invite him to join the new organization. Unfortunately, in many cases it has not been possible to find out whether a particular person is still alive and, if so, what is his address; consequently, an open invitation is now being extended to all such victims of the Nazi persecution to join the Verband Deutscher Physikalischer Gesellschaften. All those interested or anyone who can give information regarding the whereabouts of any former member should write to the Verband at Scheffelstrasse 2, Heidelberg.

Visas to the United States for Scientific Workers

A NEW survey of the effects of the present immigration legislation in the United States on issuing visas to foreign scientific workers is now being made by the Federation of American Scientists. The Federation wishes to be informed, with as many details as possible, of any case during the past two years in which a scientific worker was refused a visa or in which the issue of his visa was delayed so long that his projected visit to the United States had to be cancelled. All information will be treated confidentially, and no information will be made public without the written consent of the person involved. The Federation is of the opinion that, if the present restrictive provisions on visas to the United States are to be amended, it will be necessary for the American public and Congress to be convinced of the inadequacy of the present law. This can be accomplished only by assembling information which shows the adverse effects of the present visa policy, and the co-operation of foreign scientists in this matter is therefore essential. Information should be sent to the Committee on Visa Problems, Federation of American Scientists, 1749 L Street, N.W., Washington 6, D.C.

M. and B. Laboratory Bulletin

THE first number of the *M. and B. Laboratory Bulletin*, a new venture of May and Baker, the well-known manufacturers of chemical reagents, was published in January, and further issues are promised from time to time (obtainable free from May and

Baker, Ltd., Dagenham, Essex). This number is a well-printed, well-illustrated, folio-sized booklet of twelve pages. The promoters intend to furnish information on apparatus, reagents and techniques from the work in their own laboratories, and on matters of interest to chemists generally. There is also a hint of forthcoming articles of wide cultural appeal by outside contributors. The editors have certainly in this first number set themselves a good model and produced a well-balanced journal. The articles, all by specialists, are entitled: petroleum; a gas-scrubbing tower; potassium borohydride; and in a secondary modern school. To complete the contents, there are four abstracts, illustrated and in smaller type, which deal with the contents of a bottle; a semi-micro ozonizer; the handling of sodium; and the distillation of mercury. Each of the articles is intended to be the first of a series discussing severally the industrial production of chemicals, industrial apparatus, new reagents, and the teaching of chemistry. The inclusion of the last feature shows that thought and vision have gone to the planning of the *Bulletin*. For, manifestly, the promoters realize that in these days of the industrial importance of chemistry its teaching is of vital significance.

Composite Wood

The term 'composite wood' is not perhaps very widely known, and the editor of the new journal, *Composite Wood* (**1**, No. 1; October 1953. From 15 Beeson Road, New Forest P.O., Dehra Dun, U.P., India; price Rs. 2.8), has wisely set out on the title page his aims combined with a definition of the subject ". . . to promote the study and practice of the science and technology of composite wood (adhesives, plywood, laminated and other improved woods, building boards, etc.), and allied subjects". The journal is a welcome addition to the very few devoted entirely to the technical aspect of composite wood matters, and should be of value to the plywood and allied industries, which are now established in all parts of the world. The editor, Dr. D. Narayana-murti, is in charge of the Composite Wood Branch of the Forest Research Institute, Dehra Dun, and he and his associates have contributed extensively to this first number. The inclusion of an article by Dr. F. Kollmann, of Germany, however, indicates the international aims of the journal. In addition to four technical papers, under "Notes and News" are information on meetings of specialist societies, details of forthcoming specifications, and references to manufacturers' publications on new adhesives. The abstracts deal fully with papers bearing on composite wood, and, in the present issue, two books are reviewed. It is understood that the journal will be published every two or three months.

Maps of Africa South of the Sahara

A list of "Maps of Africa South of the Sahara" has been compiled and published by the Scientific Council for Africa South of the Sahara (Publication No. 4; pp. ii+122; from the Council, Bukaru, Belgian Congo, 1953; 15 francs). The list attempts to show the position in 1953. Historical maps have been excluded and so also have maps on a scale smaller than 1 : 1,000,000. Atlases are listed, but their contents are not detailed in broad terms. Maps of special subjects are included, such as geology, climate, vegetation and population. The mapping of Africa is advancing at a great rate, and there are few areas that have no maps. Every entry gives the scale and source of publication.

Molluscan Adaptation

The shell, mantle and organs in the mantle cavity of the characteristic *Pinna carnea* have been investigated in detail with special regard to their adaptation to the peculiar mode of life of this mollusc by C. M. Yonge (*Phil. Trans. Roy. Soc. Lond.*, B, No. 648; 1953). The shell, the shape of which recalls a partially opened fan, in the living animal is found with the pointed end embedded in the substratum with half its length, that is, considerably more than half its area, projecting freely upwards. This allows the inhalant current with its contained food particles to be drawn from clean water above the bottom and, conversely, the exhalant stream does not disturb the mud. However, standing upright and having free mantle lobes, the animal must be liable to a certain amount of silting, particularly when the surrounding mud is disturbed. We therefore find that it produces a strong exhalant current and that it has a special, powerfully ciliated waste canal well provided with mucous glands, which plays an important part in removing silt and the pseudofæces. Such a projecting shell, incapable of withdrawing, is liable to injury and the mantle is highly retractable and not attached to the part of the shell that is exposed, so that it can be withdrawn to escape injury. It can quickly carry out repairs, but it follows from its limited attachment that the shell in its projecting area is composed of the prismatic layer only. This layer is, as usual, constituted by a conchyolin network impregnated with calcite crystals arranged in prisms. There is a very much higher proportion of organic matter than in most molluscs, so that the projecting part of the shell is flexible and hence less liable to breakage. The Pinnidae alone possess a pallial organ, a large unpaired tentacular structure, the function of which appears to be that of clearing away the broken pieces of shell.

Chemical Basis of Resistance to Fungal Attack

The nature of the resistance of oats to *Ophiobolus graminis* has been investigated by E. M. Turner by testing the reactions of two varieties of the fungus to the sap (*J. Exp. Bot.*, **4**, 264; 1953). The two varieties of the take-all fungus, *Ophiobolus graminis* and *O. graminis* var. *avenae*, show a differential reaction to sap extracted from oats; the type variety, which is incapable of causing a lasting infection of oats *in vivo*, is inhibited by the sap *in vitro*, whereas var. *avenae*, pathogenic to oats, can grow in the sap. The inhibitory action of the sap is not due to a lack of food material required by the fungus, but to a specific substance or toxin. The method used for assaying toxicity is described. The inhibitor is produced in considerable quantity in the leaves and stems of oats and in smaller quantity in the roots. It appears to accumulate mainly during the period of active growth and to be less active, or present in smaller concentration, in adult plants. It can be detected in the seminal roots throughout their existence, although during the first three weeks of growth *O. graminis* can invade the cells of the cortex. It is present in greater quantity in the crown roots, which are never penetrated. A similar inhibitor of *O. graminis* can be extracted from *Arrhenatherum elatius*, but not from other grasses which, both in the field and in pot experiments, appear to be equally resistant.

Rouelle and Chemistry in France

An interesting paper in *Endeavour* (July 1953) by Dr. Douglas McKie deals with Guillaume-François Rouelle (1703–70), demonstrator in chemistry at the Jardin du Roi in Paris, and the teacher of Lavoisier and Diderot. He discusses a set of notes of Rouelle's lectures belonging to the Science Library of Clifton College, and there is a coloured reproduction of a miniature of Rouelle, also in Clifton College. Dr. McKie points out the important role which Rouelle took in the development of French chemistry; but in saying that it was he who introduced the phlogiston theory into France, Dr. McKie seems to overlook the account of the theory contained in a two-volume book "Nouveau Cours de Chymie, suivant les Principes de Newton & de Sthall", published in Paris in 1723, at a time when, Dr. McKie says, Rouelle was still a student.

Watsonia: a Journal of British Botany

Beginning with the first part of Vol. 3 (published December 1953), *Watsonia, The Journal of the Botanical Society of the British Isles*, now appears in the format of most important scientific journals (obtainable from the Department of Botany, British Museum (Natural History), London; 7*s*. 6*d*. per part). The aim of this journal is to provide a medium for the publication of original work on the taxonomy and distribution of flowering plants, vascular cryptogams and charophytes in the British Isles. Included in the present part are contributions relating to *Montia fontana*, *Nuphar intermedia* (a presumed relict hybrid), regional variation in *Alnus glutinosa*, Arctic plants not yet found in Britain, the distribution of *Dryopteris* Borreri, and notes on *Carex flava*.

Careers in Agricultural Research

A useful pamphlet entitled "Careers in Agricultural Research—Training Grants, Studentships and Fellowships awarded by the Agricultural Research Council, 1954" has recently been issued by the Agricultural Research Council. There are openings for research workers in many of the twenty-six agricultural research institutes financed by the State. In addition, certain appointments in universities and other research institutions are financed by the Council; many of these are temporary in character, but are particularly attractive to the young worker who wishes to work under the personal guidance of a distinguished scientist. The pamphlet also gives useful information about the scientific staffs of the Council and of the State-aided agricultural research institutes, and about the advisory services. This year the Council is again offering two veterinary clinical fellowships to provide opportunities for suitably qualified veterinary clinicians and pathologists of Ph.D. standing to continue research for two or three years. The fellowships will be renewable annually up to a maximum of three years and will carry a stipend of £850 a year. In addition, the Council is continuing to offer a limited number of junior agricultural research fellowships, carrying a stipend of £630 a year, to research workers of outstanding ability; and a larger number of postgraduate training grants and research studentships in agricultural and veterinary science. Applications for awards should reach the Council by March 20. Further information and a copy of the pamphlet can be obtained on application to the Secretary, Agricultural Research Council, Cunard Building, 15 Regent Street, London, S.W.1.

Postgraduate Agricultural Scholarships

The three Agricultural Departments of the United Kingdom have been allocated £625,000 over the next three years from the general allotment of Counterpart Funds given by the United States to Great Britain and other European countries for increasing productivity. It has now been announced that £25,000 of this sum will be devoted to postgraduate scholarships, the distribution being England and Wales, £15,000; Scotland, £5,000; and Northern Ireland, £5,000. In England and Wales the scholarships will be awarded in the following subjects, the qualifications required being considerably higher than for ordinary postgraduate scholarships: agricultural economics; farm management; estate management; and land economics and land use. Their value will be £400–£800 a year free of income tax plus all compulsory fees, authorized travelling expenses and a book allowance not exceeding £10 a year. Further information and application forms can be obtained from the Secretary, Ministry of Agriculture and Fisheries, 1–4 Cambridge Terrace, Regent's Park, London, N.W.1.

Australian and United Kingdom Postgraduate Research Studentships tenable in Australia

To assist in the movement of scientists between various parts of the British Commonwealth, the Australian Commonwealth Scientific and Industrial Research Organization and the Department of Scientific and Industrial Research and the Agricultural Research Council of Great Britain are collaborating in an arrangement for providing a limited number of postgraduate research studentships tenable at Australian universities or other approved Australian research institutes. Under the arrangement, an allowance of £A600 a year and other approved expenses in Australia will be made by the Commonwealth Scientific and Industrial Research Organization, and the Department of Scientific and Industrial Research or the Agricultural Research Council, as may be appropriate, will pay travelling expenses to and from Australia. Candidates must be honours graduates in science or agriculture, and must be British subjects normally resident in the United Kingdom. The awards will be tenable for two full years in Australia. Full details regarding the conditions of the studentships are being made available to all departments of the natural sciences and agriculture in universities in the United Kingdom and to technical colleges and polytechnics.

Sixth Commonwealth Entomological Conference, London

The sixth Commonwealth Entomological Conference will be held in London during July 7–16, and will be organized by the Commonwealth Institute of Entomology, London. Delegates to the Conference are being nominated by the Governments of the various countries of the British Commonwealth, including many of the Colonial Territories. In addition to the business meetings, which will be attended only by delegates, there will be open meetings on July 8, 9, 12, 13 and 15, at which subjects of wide interest to economic entomologists will be discussed. These open meetings will commence with short papers, read by invitation, the subjects being as follows: recent developments in the use of insecticides on field crops and against

locusts and tsetse flies; the effect of insecticides and other chemicals on the balance of animal populations; the development of resistance to insecticides; the estimation of losses from pests; the biological control of insects and weeds; the supply and training of insect taxonomists; pests of tropical cereal crops; developments in work on pests of stored products; problems of forest entomology; developments in termite research; recent developments in research and control of locusts and of tsetse flies. A report of the Conference will be published by the Commonwealth Institute of Entomology and will include reviews of the progress of economic entomology made by the Commonwealth countries during the six years elapsed since the last Conference. Programmes giving full details will be available about four weeks before the Conference from the Director, Commonwealth Institute of Entomology, 41 Queen's Gate, London, S.W.7, to whom all inquiries should be sent.

Development of the Mammalian Embryo: Cold Spring Harbor Symposium

The nineteenth Cold Spring Harbor Symposium on Quantitative Biology will be held during June 7–14, when the topic of "The Mammalian Fœtus—Physiological Aspects of Development" will be discussed. The primary function of the symposium will be to evaluate the principal morphological, physiological and biochemical factors that are essential for the immediate well-being and future development of the mammalian embryo. This will involve a consideration of hereditary–fœtal and maternal–fœtal relationships, as well as of the development and function of the membranes, decidua and trophoblast of the conceptus. Attention will be focused on the homœostatic factors that contribute to normal somatic and visceral development of the embryo to meet the requirements of living before, during and just after birth. Twenty-four of the participants will come from European countries, including Belgium, Finland, France, Great Britain, Ireland, Netherlands, Norway, Sweden and Switzerland. The Symposium is being sponsored by the Carnegie Corporation of New York, the National Science Foundation, and the Association for the Aid of Crippled Children. The programme and any further information can be obtained from the Biological Laboratory, Cold Spring Harbor, New York.

International Photobiological Congress in Amsterdam

The Comité International de Photobiologie (C.I.P.), known before 1951 as the Comité International de la Lumière, will be holding an international congress in Amsterdam during August 23–28, 1954, organized by the Netherlands Committee on Photobiology. The aims of the Committee are the stimulation of scientific research in the physics, chemistry and climatology of ultra-violet, visible and infra-red radiations as they pertain to biology, and the study of the effects and applications of these radiations in biology and medicine. The congress will review the present state of knowledge in certain important fields of photobiological investigation, pure and applied, and will provide a forum for the presentation of new researches; to this end three symposia will be held, with the chairman shown, as follows: photoperiodism in plants and animals (Dr. R. van der Veen, Eindhoven); the effects of ultra-violet radiation on genetic elements of cells (Dr. R. Latarjet, Paris); and the fundamental effects of light on the skin (Prof. James Hardy, Philadelphia). In addition, it is planned to have reports on photopathology, phototherapy and on methods for the measurement of radiation. The three languages of the Congress will be English, French and German. Persons wishing to attend the congress should write as soon as possible to the Secretariate Congress C.I.P., Radiologisch Laboratorium, Wilhelminagasthuis, Amsterdam.

European Congress on Clinical Chemistry

The first European Congress on Clinical Chemistry will be held in Amsterdam during September 23–28 (Royal Institute for the Tropics, 63 Mauritskade, Amsterdam-O), under the auspices of the Commission on Clinical Chemistry of the International Union of Pure and Applied Chemistry, and will be organized by the Netherlands Society for Clinical Chemistry. The two leading subjects will be: isotopes in the clinico-chemical laboratory; and physical methods of measurement in connexion with clinico-chemical problems. These subjects will be presented in symposia, made up partly of lectures given by invited speakers and partly of free communications, for which a maximum of fifteen minutes will be allowed. Those who wish to read a communication should send in their papers, accompanied by a summary of 100–150 words, to the secretary of the Congress, Ir. O. Meulemans, Racinelaan 17, Utrecht, before April 1. Excursions to various institutes and laboratories and also to places of interest in the Netherlands are being planned. The fee for the Congress is full members 25 florins (about £2 7*s*.) and those accompanying members 10 florins.

Announcements

Prof. J. K. Charlesworth, Department of Geology, The Queen's University, Belfast, has been awarded the Neill Prize for 1951–53 of the Royal Society of Edinburgh for his work on the glaciology of Scotland and his other valuable contributions to geology.

The American Association of Scientific Workers is to celebrate Prof. Albert Einstein's seventy-fifth birthday on March 14. The celebration is designed to emphasize his contributions as a great scientist, humanitarian and defender of human rights and liberties.

The Royal Dutch-Shell Group of Oil Companies is offering a research studentship in geophysics of value £450 a year (£500 for married men) and tenable for two to three years at the University of Cambridge, which is open to men of any nationality less than twenty-seven years old. Further information can be obtained from Mr. B. C. Browne, Department of Geodesy and Geophysics, Downing Place, Cambridge, to whom application must be made by July 1.

Two Ramsay Memorial Fellowships, worth £400 a year plus a grant for expenses not exceeding £100 a year, are being offered for chemical research; they will normally be tenable for two years. One of the Fellowships will be limited to candidates educated in Glasgow. Further information can be obtained from the Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, Gower Street, London, W.C.1, to whom application forms must be sent not later than April 21.

BRITISH IRON AND STEEL RESEARCH ASSOCIATION

WORK AT SHEFFIELD LABORATORIES

THE laboratories of the British Iron and Steel Research Association in Sheffield, which have recently been opened, have been built to provide laboratory and plant facilities for three of the Association's five divisions—those concerned with steelmaking, metal-working and metallurgy.

They have been planned in part to overcome a difficulty met with in much industrial research and particularly in that connected with the iron and steel industry. This is the very great difference in scale between laboratory bench-work and industrial-plant operations, which tends to make experiment on operating plant extremely expensive and diminishes the value of much preliminary work.

In addition to the more usual research facilities and offices, therefore, there are at Sheffield two so-called 'plant laboratories' in which experiments not far removed from the scale of steelworks operations can be carried out. They contain, in particular, an electric arc furnace, a rolling mill, a forging press and a high-speed wire-drawing machine. The plant laboratories are single-story buildings of 10,000 sq. ft. and 4,000 sq. ft. floor area respectively. There is a third new building, a three-story main block of approximately 30,000 sq. ft. floor area. There are also four buildings which were previously on the site, one of which is occupied by the Cutlery Research Council, an independent body which makes use of the Association's central administrative services, and works in close liaison with the three divisions of the Association.

Steelmaking Division

The Steelmaking Division is naturally concerned particularly with fuel efficiency, and carries out many field-trials and observations on industrial furnaces. Fairly recent extensions concern the measurement of flame heating-power and its relationship to changes in furnace-operating conditions. This is an attempt to apply in steelworks practice the results of the work of the International Flame Radiation Committee on the experimental furnace at Ijmuiden.

One of the Ijmuiden results requiring further study is that steam reduces flame-radiating power, yet an increase in steam/oil ratio is known to give faster melting in many furnaces. This may be due to several combined effects; for example, increase of steam will increase the momentum of the jet, and may therefore increase the convective heat transfer, which is known to be very important during the melting-down stage.

Other field-work related to fuel efficiency is that concerned with the infiltration of cold air in open-hearth furnaces. Two techniques of measuring the air or gas flow in the flue system of such furnaces have been developed. The first was based on Pitot tube surveys across sections of the system, which proved not to be of general application because many furnaces have no suitable location for Pitot tube measurements. In the second technique, therefore, radon was injected into, and traced through, the system. This technique is applicable to all furnaces, and permits a much more detailed survey to be made of the flow in furnace systems, including leakages at valves. Investigations of flow are usually accompanied by temperature measurements of the preheated air supply. The many instruments such as suction pyrometers, radon tracer and various calibration equipments needed for this field of work are kept at the Association's Sheffield laboratories ready for use at member firms' works.

Work carried out in the Sheffield laboratory itself includes a number of intensive studies on the chemical engineering aspects of mixing metals and slags. Experiments have been done on the rate of reaction between metal and slags using various methods of stirring. Some of the more spectacular of these involve breaking down the molten iron into very small droplets (1 mm. diameter and less), and allowing them to fall into the molten slag. In all such experiments the iron-slag mixtures were water-quenched within a minute or so after the additions of iron, and by carefully crushing the slags it was possible to extract the iron droplets, grade them into various size fractions and determine their sulphur contents. The results showed that it was possible to effect a high degree of desulphurization (80 per cent or more) in seconds of time provided a sufficient degree of slag/metal mixing could be achieved. However, the experience obtained suggested that atomization methods would be impractical on a large scale.

The Steelmaking Division has at the laboratories a 10-cwt. electric arc furnace of a design to facilitate experimental work. This is being used for, among other things, studies of the economics of this method of steelmaking with the view of possible extension of its field of usefulness. Many types of high-quality bulk steel which it would be technically advantageous to make in electric arc furnaces are only just beyond the economic borderline and comparatively small improvements in electric furnace practice might bring them over. In particular, power and electrode consumption are being studied both on production furnaces and on the experimental furnace. The experimental furnace has a very large transformer for its size (500 kV. amp.), and the effects of high power inputs are being examined. The biggest effect so far found is, naturally, that of rate of power input during melting down on power consumed during this period, and in the Association's furnace about 20 per cent less power is required with an input-rate of 500 kV. amp. than with 250 kV. amp.

A further important purpose of the furnace is to provide molten steel for a variety of experiments, mainly on problems of casting. A commercial-scale continuous casting plant to the Association's design is now being built at a Sheffield works, and work continues on the many practical problems involved.

Mechanical Working Division

The Mechanical Working Division has a wide range of metal-forming and experimental plant housed in a fine, one-story building of 10,000 sq. ft. floor area. A 14-ft. four-high reversible cold-rolling mill is equipped to allow as wide a field of cold-rolling research as possible to be undertaken. Operating conditions have therefore been extended far beyond the normal production limits. At present the mill is equipped with a method of automatic gauge control developed by the Association on the basis of some years of work on the causes of gauge variation in rolled strip, in the course of which useful fundamental contributions to knowledge of the plastic behaviour

of metals have been made. Continuous measurement by roll force meters of the separating force of the rolls indicates gauge variation; this is fed into a control circuit which immediately corrects variation either by altering the strip tension or the gap between the rolls. As an example of the potentialities of the method, a rundown of gauge of nearly 0·002 in. on 0·049 in. between 30 ft./min. and 250 ft./min. regularly occurred on an experimental 10-in. two-high mill without automatic control; with it, the entire strip was held to within ± 0·0001 in. at all speeds. The demonstration was repeated on a much larger scale by equipping a 56-in. wide four-stand cold reduction mill, one of the largest of such plants in Europe, with a similar type of control. It was found possible, even on this scale, to roll consistently at all speeds to far closer tolerances than are at present possible without automatic control.

After these trials and demonstrations, a period of intensive development is necessary, in which the Association's 14-in. experimental mill will play an important part. The best methods for development have yet to be decided, and there are other rolling variables, such as thermal expansion and bearing clearance, which may need to be considered and which threaten to increase the complexity of the equipment needed.

Other experimental metal-working plant includes a 200-ton capacity hydraulic forging press and a high-speed two-hole wire-drawing machine with a maximum finishing speed of 5,000 ft. per min. The press is being used to study the effect of forging strain on mechanical properties. Different tool-ratios and reduction-rates are being used, and attempts are being made to correlate the resulting mechanical properties within the material with the actual forging strains as determined from geometrically similar experiments using 'Plasticine'. It may then be possible to specify with more certainty the optimum forging reduction and the sequence of operations necessary to produce desired properties.

The wire-drawing machine is being used for examining problems of high-speed wire-drawing, in particular the limitations imposed by lubrication. The film thickness of the lubricant is being studied by measuring the electric resistance of the die-wire interface. This resistance is much larger than one would expect if the film were only a few molecules thick. Moreover, it is markedly dependent on speed. In one instance, the resistance increased from about 10 ohms per sq. cm. at 5 ft. per min. to about 50 ohms per sq. cm. at 50 ft. per min. with peaks exceeding 500 ohms per sq. cm. Experiments at speeds prevalent in industry are in progress and give a similar picture. Current investigations are also concerned with improved methods of applying the lubricant; for example, by electrodeposition from solution on to the moving wire. It is hoped to obtain in this manner a more consistent thickness of lubricant film and therefore a more uniform performance of the die.

The success of experimental research in metal-working depends to a large extent on the development of theory both to guide the choice of experiments and also to enable the results to be effectively interpreted. There is within the Mechanical Working Division a section concerned with theoretical plasticity, which has made useful contributions to the practical work. Exact and approximate plastic-rigid solutions have been shown by experiment to be a good guide to the behaviour of real metals.

Metallurgy Division

The Metallurgy Division at Sheffield includes facilities for heat-treatment, general metallurgical examination, mechanical, magnetic and electrical testing and X-ray structural studies as well as for chemical, spectrographic and vacuum fusion analysis. The fatigue-testing laboratory and the high-frequency electric furnace, in which 56 lb. of metal may be melted and cast *in vacuo*, are of particular interest.

An important part of the work is concerned with researches on pure materials. Small variations in the amounts of residual elements found between different casts of a steel having a given nominal composition can have a large effect on its properties. Research concerned with the effects of composition on the properties of steels carried out on alloys made from pure materials provides valuable background information. As such research is expensive and cannot be undertaken by every industrial laboratory, it is particularly suitable for a research association. At present this work includes the study of the effects of nitrogen and carbon on the strain-ageing characteristics of pure iron, and the effect of impurities on the magnetic and electrical properties of pure silicon–iron sheet, while a study of the properties of alloys made from pure materials, and having compositions similar to the nominal compositions of commercial steels, is contemplated.

In the studies of silicon–iron sheet of the type used for transformer cores, the effect of small controlled amounts of nitrogen are being studied with the view of determining the indirect effect which nitrogen has through its influence on the crystallographic texture of the cold-rolled sheet, and the direct effect of nitrogen as an impurity. The variations in texture are being studied with a torque magnetometer which gives an indication of the anisotropy, and also by orthodox X-ray methods which give quantitative information about the texture. The magnetic properties of the silicon–iron are being studied by means of a standard instrument.

The fatigue laboratory is equipped with twelve fatigue-testing machines of the two-point loading rotating bending type, similar in design to those used by the Mechanical Engineering Research Organization and the National Physical Laboratory. The speed of the machines is controlled, and rates up to 5,000 r.p.m. are possible, at which speed the machines are clear of any resonance which might influence the results. Each of the twelve machines is therefore able to provide approximately 7,000,000 stress cycles every 24 hr.

The main programme is concerned with the systematic sampling of three commercial casts of steel, using some 3,000 test pieces, to gain information on likely variations within casts of steel and between different casts of steel of the same specification. Information is also sought on whether structural variations in the ingot give rise in the rolled or forged products to significant variations in fatigue properties, and if they do, whether these variations are more pronounced in some ingots of a cast of steel rather than in others. The programme takes into account the fact that it is now widely appreciated that such values as fatigue life, fatigue or endurance limit are not exact values but are, in fact, statistical in nature. It has therefore been planned in collaboration with the Association's operational research section.

BIOLOGICAL SPECIFICATION AND BIOLOGICAL STANDARDS IN THE BRITISH PHARMACOPŒIA, 1953*

By PROF. A. A. MILES, C.B.E.
Lister Institute, London, S.W.1

A NUMBER of reputable drugs in common use to-day have been fully explored by chemists and physicists, so that we know their chemical constitution, and, in many cases, can synthesize them. In a publication like the "British Pharmacopœia, 1953", which specifies these drugs for public use, it is enough for most drugs to state the degrees of chemical purity required to ensure that the medical practitioner and the general public have medicines upon which they can rely. But there are a number of substances available for the prevention and cure of disease, usually obtained from animals or plants, which we recognize mainly by their biological activity, and although we know something of their chemistry we do not know enough to recognize an active preparation by chemical tests alone.

Some of these 'biologicals' may in time yield to chemical analysis, if they are small enough or simple enough in structure. It is significant that, of the substances in the "Pharmacopœia" the molecular weight of which can be stated, only sixteen are greater than 500, and two greater than 1,000. We shall wait long for the chemistry of any active principle, not a polymer, that has a molecular weight much greater than 1,000. In the meantime, drugs like insulin and the antitoxic globulins with molecular weights in the tens and hundreds of thousands, and the various immunizing antigens and vaccines, are quite beyond chemical specification. Apart from tests of identity, the most important biological specifications that complete the inadequate chemical and physical specifications in the pharmacopœial monographs are the potency requirements. Now biological potency is by definition a measure of activity in some biological systems. The system may be a whole animal, such as a cat; part of an animal, like a guinea pig uterus or a suspension of red blood cells; or a culture of bacteria. Whatever the system, our first idea of potency is the amount of a substance that does something observable to it. Since we cannot test the activity in the human subject, we have in all cases to make the assumption that the effect we measure in the biological system is an indication of the effect we want to produce in the human patient. Sometimes that assumption proves to be unjustified, because we are using the wrong biological system, or observing the wrong effect in the right system; but in most cases it has proved to be correct. Our next problem is to translate the effect we observe in the test system into a measure of the potency of the drug.

The estimation of potency as the amount of a substance that produces a defined response in a given biological system is subject to the notoriously high variability of such systems, including the day-to-day variability in one laboratory and variability between laboratories. The limits of error of such 'direct' estimates of potency can only be guessed, and the reliability of such guesses parallels our success in achieving a precise specification of the biological test system—in most cases an impossibility. When we can make only very imprecise measures of potency, clearly we are in no position to specify a drug that is poisonous in an over-dose or endangers the success of the treatment in under-doses. Happily, in a number of substances the biological activity of which can be measured only by the direct method, over-dosage is not medically dangerous, and we can ensure that the patient gets enough by giving plenty. This state of affairs applies, for example, to the prophylactics used for the prevention of diphtheria. With a substance like insulin, where an over-dose may mean one kind of coma and an under-dose another kind, our methods must be precise. To substances like this it is possible to apply the more precise, 'orthodox' bioassay, in which the biological test system is in effect specified for each assay by testing a standard preparation of the drug in parallel with the unknown. Potency is then expressed in terms of the standard, not, as in the direct assay, in terms of an unstandardizable animal or other biological object. Biological standards may be used in this way when the active material can be preserved in a stable form, and when it is reasonable to assume that the active principle in the standard is homogeneous and similar to that in the material being assayed; and that the biological response observed is due to the substance the therapeutic action of which it is intended to exploit. In the "British Pharmacopœia" the biological standards prescribed for use are either international standards maintained by the World Health Organization or, when there is no international standard, British standards established by the Medical Research Council.

Bioassay of a drug is sometimes called 'standardization'. The term, however, should be confined to the establishment of the standard preparation. Thus, diphtheria antitoxin was standardized once and for all when, in 1922, the International Standard for Diphtheria Antitoxin was set up and units of potency accepted. Assays of potency made in terms of this standard are parts of the 'specification' of therapeutic and other preparations of diphtheria antitoxin. We thus have a number of drugs the total specification of which, as in a pharmacopœial monograph, include a biological specification in terms of a standard and, where no standard is available, some much less precise biological specifications in terms of a biological test object.

The bioassays in the "British Pharmacopœia, 1953" are introduced by a section on the principles of modern bioassay. Most assays are now designed to yield answers such that the responses to graded doses of the standard and the test preparation can be transformed by suitable arithmetical manipulations into numerical values that will yield a linear response when plotted against the logarithm of the dose; and when both the standard and test preparation give substantially parallel linear dosage-responses, the potency ratio is readily derived from the logarithmic distance between the two lines. Since the 1948 "Pharmacopœia", assay methods and biological standards have been made available for aureomycin, scarlet fever antitoxin, globin zinc insulin, *d*-tubocurarine and dimercaprol.

Globin zinc insulin is interesting because, although it is used clinically as a 'delay' insulin, it is not possible to demonstrate any appreciable delay effect in rabbits without using prohibitive numbers of animals. Consequently, there is no test for delayed action in the "Pharmacopœia".

* Substance of a paper before the Pharmaceutical Society, read on December 10, 1953.

The specification of immunological products leaves much to be desired from the formal point of view. In few of the antitoxins for which there are standards is an orthodox assay, with calculation of fiducial limits of error, prescribed; but the precision and accuracy that might be attained if better assays were defined are probably unnecessary. For a large group of substances—the living vaccinia virus which constitutes the smallpox vaccine, and the living suspension of B.C.G. (Bacillus of Calmette and Guérin) which is a tuberculosis vaccine—there are no biological standards; they are all assayed directly in laboratory animals, with the consequent risk of a highly variable result. With B.C.G. vaccine, the results of even the various direct assay and tests have only a retrospective interest, because they take three weeks to six months to complete and the vaccine keeps its potency only fourteen days after issue for use in man. The 'dead' vaccines—that is, bacterial suspensions of killed typhoid and paratyphoid bacilli, whooping cough bacilli, plague bacilli and so forth—are not assayed for potency at all. At present, reliance is placed on the selection of the right strain of microbe to start with, and its proper cultivation and treatment in the manufacture of the vaccine. In other words, the specification stresses the 'pedigree' of the finished product as well as its properties at the date of issue.

With the exception of thrombin, hæmoglobin and fibrinogen, none of the human blood products in the "Pharmacopœia" can be assayed biologically, or even specified in any precise way; but there are precautions to be taken in selecting the donor, whose blood will be the source of the various blood products —"Whole Blood", "Human Serum" or "Fibrinogen", and so forth—all of which are, on the face of it, very sketchily described.

These gaps in the specifications are, however, only apparent. It must be emphasized that all such pharmacopœial substances—immunological and human blood products—for which the biological specification is superficially inadequate are under the control of the Therapeutic Substances Act. That is to say, they can be manufactured for sale only under licence from the Ministry of Health; it is consequently not enough that a vaccine should be prepared in such a way that it passes a biological test as laid down in the "Pharmacopœia". Its control ends, not begins, with the test of the finished product. It has always been the policy of the Ministry of Health in applying the Therapeutic Substances Regulations, and of the Medical Research Council in advising on the research aspects of their application, to recognize that the control of these biological substances begins in the producing laboratory, so that all stages from the raw material to the finished product are in charge of expert staff who work so as to leave no loophole for variability so gross as to lead to unwanted results in the use of the drug.

The prescribed methods of control in the "Pharmacopœia" are instructive in that they range from the simplest tests of activity in the animal to the most elaborate assays which in design and execution would satisfy the most meticulous biometrician. The differences necessarily reflect the differences in our current knowledge of these substances and how to handle them in the laboratory. Imperfection there must be, because we can often recognize and purify an active principle which it would be wrong to withhold from the practitioner of medicine until we know exactly what it is. But it is comforting to reflect that no such substance is included in the "Pharmacopœia" unless the imperfections in our knowledge have been removed at least so far as knowing the potentialities of the drug, both beneficial and dangerous. The biological specifications in the "Pharmacopœia" ensure that we know well enough what amount of a drug will have no effect; what amount will have a beneficial effect; and when the second amount is exceeded, where the danger zone begins.

ALGAL PHYSIOLOGY AND BIOCHEMISTRY

IT has long been recognized that certain algae are particularly suitable as experimental material in the investigation of some of the classical problems of plant physiology and biochemistry. Valuable and extensive information about them has been accumulated, but it seems that concentration upon such species has resulted in inadequate appreciation of the variety of physiological behaviour and chemical activity which is to be found among the algae. A symposium on the physiology and biochemistry of this group of plants, in which the contributions were mainly concerned with species more familiar to marine and freshwater biologists than to most plant physiologists, is therefore of particular interest and an indication of increasing realization of the intrinsic interest of algae. Such a symposium, arranged by the British Phycological Society, was held under the chairmanship of Prof. W. H. Pearsall in the Botany Department of University College, London, on January 1.

In a paper on the physiology of algae other than *Chlorella*, Dr. G. E. Fogg directed attention to features in which certain species being investigated by the Unit for Algal Physiology at University College differ markedly from *Chlorella*, the genus of algae best known to the physiologist. *Monodus subterraneus*, a member of the Xanthophyceae, is morphologically the analogue of *Chlorella*, but unlike members of this genus cannot tolerate wide variation in the composition of the mineral medium in which it grows and appears to be an obligate phototroph. *Anabaena cylindrica*, a nitrogen-fixing blue-green alga, has proved particularly suitable for investigation of the metabolic role of molybdenum. Results recently obtained show that this trace element is not specifically concerned in nitrogen metabolism but that it exerts its effects *via* carbohydrate metabolism and that the symptoms of its deficiency can be annulled in *Anabaena* if a suitable intermediate such as fumarate is supplied. Although all algae so far examined from this point of view, including *Chlorella* sp., produce extracellular peptides to a greater or lesser extent, *Anabaena* is a particularly favourable organism for the study of this phenomenon. Formation of chemical complexes with toxic or nutrient substances by the extracellular polypeptide of this alga can in certain circumstances have important effects on growth of the organism. The variation in proportions of carbohydrate, fat and protein shown by *Chlorella* spp. according to the conditions under which they are grown is also to be found in other algae, although in *Tribonema aequale*, for example, the possible range appears to be more

CORRECTION

We regret any inconvenience caused to readers of *Nature* by our announcement, in the issue of February 20th, that **Thorpe's Dictionary of Applied Chemistry, Volume (XI)** would be published in February. This volume will not be ready for some months, and more definite news will be included in later advertisements.

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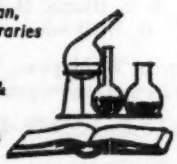

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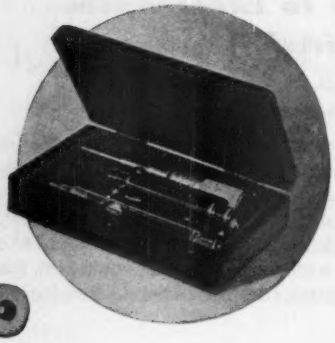

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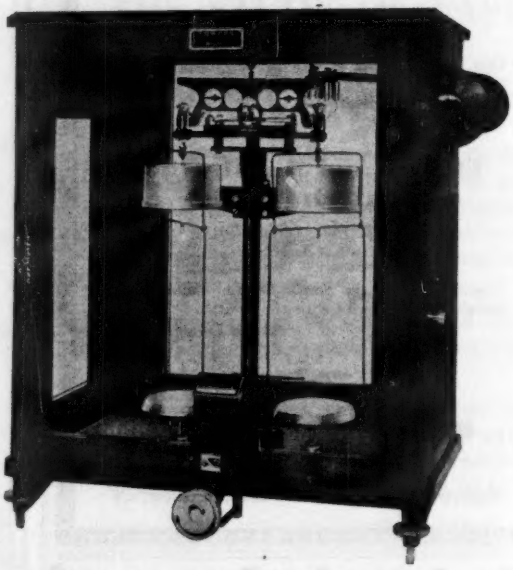

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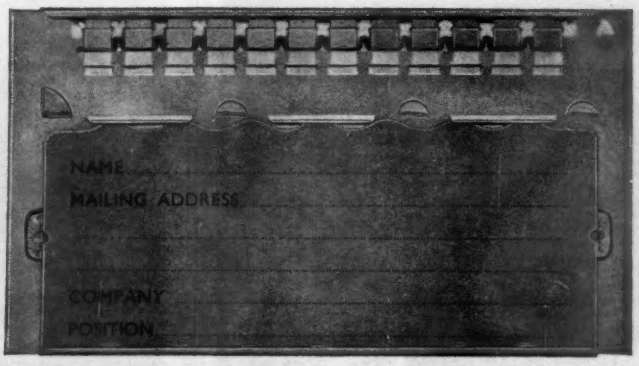

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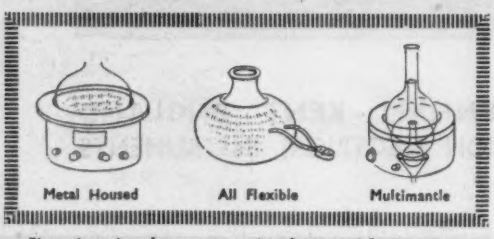

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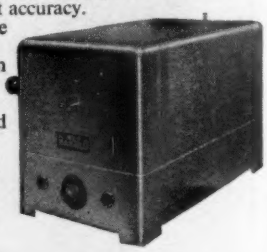

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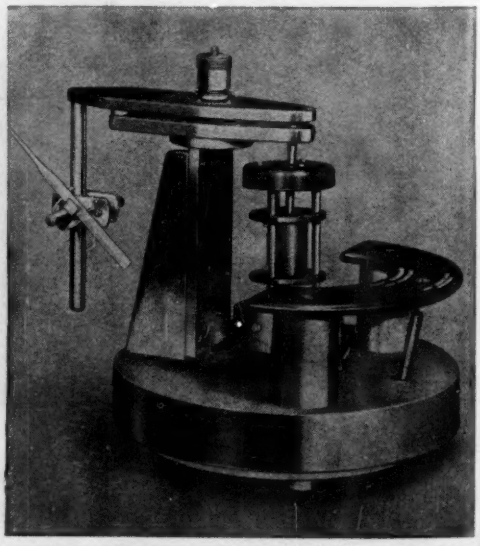

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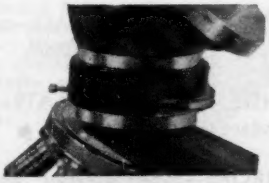

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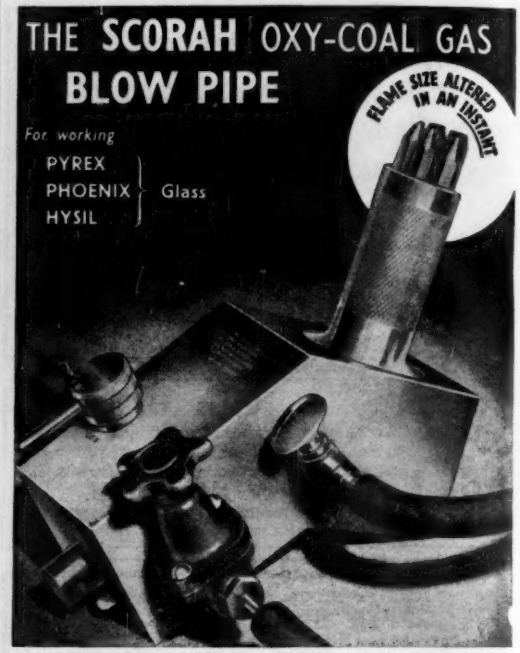

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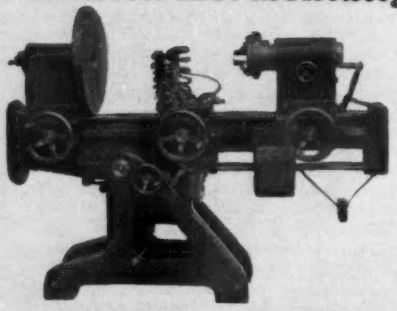

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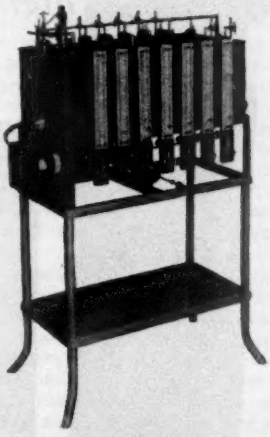

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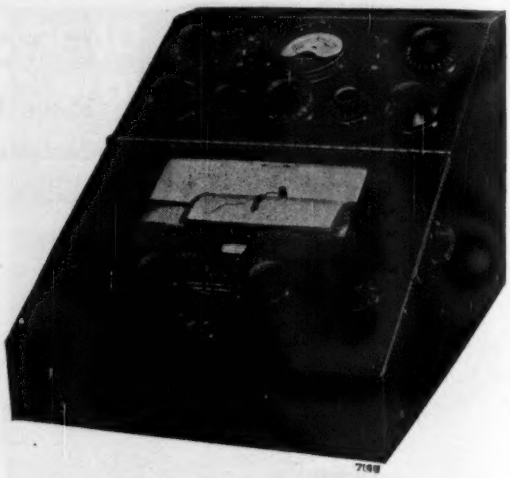

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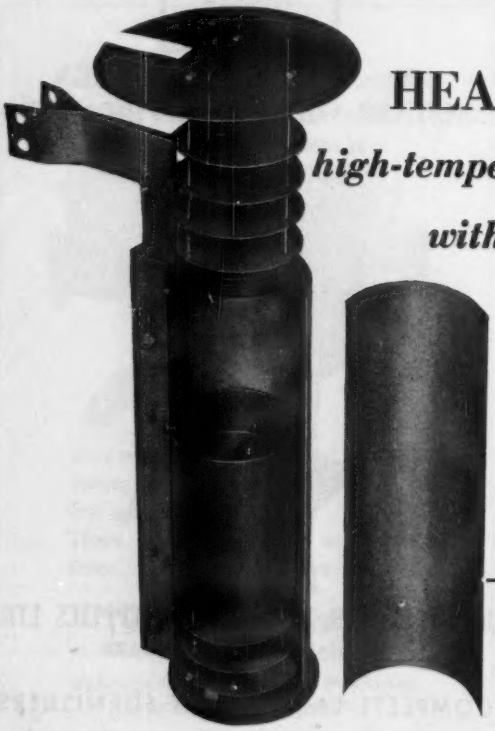

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restricted. Blue-green algae seem to be incapable of accumulating high proportions of fat, as do *Chlorella* spp., under conditions of nitrogen-deficiency. *Botryococcus braunii*, which possesses chlorophyll *b* and which must therefore be assigned to the Chlorophyceae, is remarkable in accumulating high proportions of unsaponifiable lipoid.

Dr. L. Fowden (University College, London), in reviewing present knowledge of the amino-acids and proteins of algae, pointed out that although the early work on this subject represents a considerable technical achievement, analyses by modern methods such as paper chromatography are not only performed more rapidly but also afford much more reliable results. Study of free amino-acids has shown that in *Chlorella vulgaris*, at least, the pattern of their metabolism is similar to that in higher plants. Among the free amino-acids, glutamic and aspartic acids and alanine are present in highest concentration, and other amino-acids can be formed by transamination from these to appropriate keto-acids. There are particular amino-acids characteristic of certain groups; this affords another example of the correlation to be found between biochemistry and classification in the algae. Quantitative analyses of the amino-acids of the bulk proteins of several algae, including *Chlorella*, *Tribonema*, *Navicula* and *Anabaena*, have now been made and show that the same amino-acids are present in much the same proportions as in the green leaves of higher plants. Early reports that certain amino-acids are absent from the proteins of some groups of algae were based on results obtained with inadequate analytical techniques. The proportions of different amino-acids in the bulk proteins of *Chlorella vulgaris* do not change markedly during the growth of cultures. Nothing is known as yet of the individual proteins of algae; but study of them is beginning with attempts at their separation by electrophoretic methods.

A paper by M. R. Droop (Marine Station, Millport) was concerned with the biology of hæmatochrome in *Haematococcus pluvialis*. The accumulation of this pigment, the principal constituent of which is the carotenoid astaxanthin, is known to be promoted by high light intensity, by the supply of acetate, or by nitrogen deficiency. These effects have been confirmed; but it has been found that hæmatochrome is also formed when growth is limited by phosphate, nitrate being in excess. No hæmatochrome appears while cell multiplication is going on; when growth has ceased, its accumulation is most rapid when both organic carbon and carbon dioxide are available and slowest when carbon is in short supply. The effect of organic carbon is independent of light. It seems, therefore, that the formation of hæmatochrome is promoted by factors which inhibit cell division but not carbon assimilation. Superficially, hæmatochrome appears to be a reserve product, but its utilization and its relations to starch and fat have not been investigated. The red *Haematococcus* which occurs naturally is in a non-dividing condition, the dense populations which are often met with appearing to be built up rapidly from large numbers of aplanospores.

The kinetics of growth of a marine unicellular alga, long known as *Nitzschia closterium* forma *minutissima* but of doubtful affinities, were described by Dr. C. P. Spencer (Marine Station, Bangor). This form, unlike most marine algae, is sufficiently robust for routine laboratory handling and has the further advantage that its growth may, under certain conditions, be followed accurately by determination of the optical density of the culture. The alga undergoes a period of exponential growth following inoculation into fresh medium, but even under constant conditions irregularities sometimes occur in this phase. These irregularities disappear on repeated subculture in medium of the same composition, and appear to be connected with adaptation to altered phosphate concentration. A lag phase is observed following inoculation into fresh medium if the inoculum is taken from a culture in which maximum cell density has been reached. Unless a massive inoculum is used, a lag phase of about five hours is also observed if the parent culture was in the early exponential phase. This suggests that some factor excreted by the cells must reach a certain concentration in the medium before exponential growth can begin, and this idea is confirmed by the finding that there is no lag following inoculation from the early exponential phase into medium in which growth has already occurred and which has been enriched with phosphate and nitrate. These results were obtained with media in which nitrate was limiting; phosphate-deficient media may produce cells having a lag phase of the order of ninety hours. Relatively high concentrations of phosphate sometimes exert a lethal effect, a phenomenon that has been observed with certain other algae and which may make it advisable to use phosphate-poor media when bringing a species into culture for the first time.

The mechanism of the absorption of glucose by *Scenedesmus quadricauda* was considered in a paper by F. J. Taylor (Queen Mary College, London). In oxidative assimilation by this organism, one-sixth of the glucose taken up is oxidized, the remainder being synthesized to polysaccharide. The increase in oxygen uptake following addition of glucose is immediate, and the uptake of glucose remains linear with time. This last fact and the observation that oxygen is essential for glucose uptake suggest that the process is one of active absorption rather than one of simple diffusion. Various observations are consistent with the idea that this active absorption is effected by a phosphorylase situated on the cell surface. Thus, no free glucose has been detected inside the cells by chromatographic methods, and phloridzin, which is apparently a specific inhibitor for phosphorylases, inhibits glucose uptake without reducing the rate of endogenous respiration. The rate of uptake of glucose remains constant as its concentration is increased until, corresponding with plasmolysis, there is an abrupt rise. This may perhaps be due to the uncovering of further enzymatic groups in the plasma membrane as it parts from the cell wall. No marked effect of age of culture on rate of glucose uptake was observed. Light has been found to stimulate the process.

Demonstrations illustrated some of the techniques in use in University College, London, for the study of algae. These included culture apparatus for various purposes, the most elaborate being an apparatus for continuous culture of unicellular algae, in which constant conditions and cell density are maintained by electronic control. Numerous species of unicellular and filamentous algae, both freshwater and marine, were exhibited in small-scale culture together with large-scale cultures (36- and 10-litre respectively) of *Chlorella* and *Tribonema*. The preparation of cell-free homogenates of algae for protein analysis was demonstrated, and various cytological preparations of blue-green algae were also exhibited.

NEW ZEALAND DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

ANNUAL REPORT FOR 1952–53

THE twenty-seventh annual report* of the Department of Scientific and Industrial Research, New Zealand, covers the year ended March 31, 1953. It includes the Minister's statement, the Secretary's report and reports from the several branches of the Department, as well as from the Cawthron Institute, the Commonwealth Agricultural Bureaux, the research associations, the Manufacturers' Research Committee and the university colleges to which grants were made by the Department. The Minister's statement, stressing the way in which, particularly in the primary industries, the Department is assisting to put the results of scientific effort into practical use more rapidly than ever, and the satisfactory extent to which the Department has succeeded in establishing effective collaboration with other bodies in dealing with economic scientific problems, suggests that it is now an appropriate time to review the basis upon which research associations are financed by industry and by the State.

The Secretary's report notes a reduction in staff during the year from 1,012 to 931, that in professional staff being from 402 to 374. There were also considerable reductions in capital charges, in purchases of equipment and supplies and in travelling expenses, but reductions were spread as widely as possible. A critical analysis of the Department's expenditure of £1,020,720 estimates that 26 per cent was on long-term applied research; 22 per cent on scientific services for other government departments; 17 per cent on research and services to primary industry; 10 per cent each for defence science and on administration, information service, etc.; 7 per cent on research and services to manufacturing industry; 5 per cent on research grants; and 3 per cent on grants to British Commonwealth and international scientific institutions. It is estimated that the expenditure on research, as distinct from services, is probably about 43 per cent, and, reviewing the results of this expenditure over the past twenty-seven years, the Secretary points out that grassland research has enabled New Zealand, by breeding new strains of pasture plants and studying their management and utilization, to attain front rank as a pasture country with an exceptionally high yield of meat, butterfat and wool per acre. The annual production of fodder has been largely increased, the season of grass growth being extended by at least two months. New methods have been used for combating such serious diseases as facial eczema and bloat, and a considerable export trade has been built up in pedigree grass and clover seeds.

Soil surveys of the whole of New Zealand have been completed, and on this basis areas of erosion, of deficiency in lime and phosphate, and of the occurrence of plant and animal deficiency diseases have been mapped and the foundation thus laid for the utilization of the Dominion's soil resources. The areas liable to bush sickness have been defined and are now being brought into successful production. Research into plant diseases has brought many of them under complete control and others have been made amenable to spray treatment. The fruit-growing industry has been provided with sound methods for the control of fungal and bacterial diseases and of insect pests, and bunt and smut diseases of barley and wheat are now rare. Research in fruit transport has eliminated the serious losses which were common twenty-five years ago in shipments to the United Kingdom. The serious physiological disease of apples, known as corky core, has been traced to boron deficiency and is easily and cheaply remedied. The wheat industry has been provided with a series of varieties unsurpassed in yield and quality of flour and in marked contrast to the Tuscan variety which they have replaced. The two most serious insect pests of pastures, grass grub and grass caterpillars, have been brought under control economically, as well as the diamond back moth which in bad seasons inflicted losses of turnips, rape and cabbage estimated at tens of thousands of pounds; and methods have been found by which South African citrus fruit may be imported to New Zealand without risk of introducing serious insect pests.

Recent research has discovered the cause of the yellow-leaf disease threatening the phormium industry and has indicated remedial measures which have removed the worst threat. Research in the tobacco industry since 1920 has led to the area under this crop being doubled as well as the yield of leaf per acre. The linen-flax industry has been established on research carried out by the Agronomy Division at Lincoln, the fish-liver oil industry on the investigations of the Fats Research Laboratory into the vitamin content of New Zealand fish livers, and the agar industry on the seaweed researches of the Botany Division and the Dominion Laboratory. These and other advances due to the research activities of the Department have afforded savings in any one year that would repay the whole of the State expenditure of nearly £8 millions on the Department during the past twenty-seven years.

The Secretary points out that so far no agreement has been reached regarding an adequate organization for the scientific problems of the building industry: in the Department's view, such an organization should be capable of adapting advances in building research institutions overseas to the special conditions of New Zealand, of undertaking research into New Zealand building problems and of disseminating knowledge to the industry. Progressive improvement in accommodation in many branches of the Department is recorded, including new premises for a section of the Geological Survey and for the Geophysics Division. The removal in the near future of the Botany Division headquarters to Christchurch should relieve the serious overcrowding in this Division of many years past.

Outstanding economic achievements of the year include savings estimated at £30,000 to Auckland tomato growers through the elimination of *Botrytis* disease by incorporation of a special fungicide in the hormone sprays used to induce setting of the fruit from early flower trusses. Investigations with the use of hormone sprays have now indicated that some 70 per cent of the cost of thinning apples in Hawke's Bay orchards can be avoided, with savings estimated at £20,000 annually, while in the fruit-growing districts of Central Otago treatment of pears, peaches and nectarines with zinc salts has checked die-back and restored normal vigour. Investigations on frost injury to fruit trees by facilitating more reliable pre-

* New Zealand. Twenty-seventh Annual Report of the Department of Scientific and Industrial Research. Pp. 108. (Wellington: Government Printer, 1953.)

diction of dangerous frosts has offered operating economies in fuel and labour. The Crop Research Division has produced strains of Blue Prussian and Greenfeast peas of proved resistance to wilt diseases, thus permitting higher yields and the more frequent use of peas in cropping rotation.

Tests in ground infested with black root-rot disease indicate that two varieties of tobacco introduced from the United States give yields higher by more than 500 lb. of leaf per acre, thus enabling tobacco to be grown profitably on areas abandoned on account of infestation by root-rot. Inoculation of the soil with methyl bromide has been shown to be as effective as steam sterilization for control of weeds in tobacco seedling beds, and the application of maleic hydrazide when the tops are removed eliminates all subsequent labour in the removal of lateral shoots. A considerable measure of control of stone fruit blast has been obtained by the Plant Diseases Division with the antibiotic streptomycin; nodule bacterial work in the same Division has produced a strain that promotes rapid establishment of clover in the raw pumice soils of the Wairakei–Tampo area, and complete control of thrips on onions has been obtained with DDT spray applied as an emulsion. The headsnut disease and cutworm pests, which have been making serious inroads on the yields of maize in Poverty Bay, have been brought under control by means of a heavy dressing of fungicide in which an insecticide that deals with the cutworms is incorporated.

By a simple modification of the diffusion process of treating timber with boric acid, in which the green sawn timber is passed through a bath or spray of concentrated boric acid/borax solution and then held in block-stacks for a specified period, an inexpensive method of treatment has been evolved which was being tested on a semi-commercial scale. Promising results in breeding a new improved type of perennial ryegrass have been obtained in first-generation hybrids from perennial and short-rotation rye-grass, and the establishment of a well-balanced pasture-sward during the initially difficult stages has been facilitated by halving the amount of grass seed in an ordinary pasture mixture. At the Te Awa hill station the carrying capacity of pastures was increased to four ewes per acre compared with one wether a few years ago. Investigations on the control of grass grub and perina, which cause losses estimated at £6 millions annually, are continuing; but meanwhile the Entomological Research Station's recommendations for a DDT treatment costing less than £1 an acre has been substantiated.

Detailed soil surveys of the Gisborne Plains, Foxton Sands, Canterbury Plains and Downlands and the Heathcote Valley horticultural areas, and detailed geological and geophysical surveys of the Wairakei and Te Teko geothermal areas were completed during the year. Surveys were being extended northwards to the Waiotapu area, and the use of the steam resources now being tapped was under consideration for the production of heavy water. The Department was also associated with the scientific aspects of the completely successful shipment of chilled beef, the first since pre-war years, by the New Zealand Meat Producers' Board to London on the *Dominion Monarch*. Various sections of the Department gave valuable assistance to several aspects of the work on the Maraetai hydroelectric dam, including stress and vibration measurements, and advice on paints and their protection; a special feature was the examination by the gamma-ray equipment of the Dominion Physical Laboratory of all welds within the metal of the penstock controls and the location of flaws. In consequence, repairs to the penstock equipment were made in New Zealand, and the dam was brought into operation several months earlier than scheduled. The five industrial research associations of the Department all had successful years, and the Manufacturers' Research Committee gave special attention to the organization of trade research groups within the Auckland Industrial Development Laboratories and the Canterbury College Industrial Development Department so as to provide scientific assistance to manufacturing industries too small to form research associations.

ROYAL OBSERVATORY, CAPE OF GOOD HOPE

REPORT FOR 1952

THE report of the Royal Observatory, Cape of Good Hope*, for 1952, which has recently become available, shows that it was "a reasonably satisfactory" year for the Observatory. The weather, from the point of view of observing, was well above average during the first part of the winter, and good progress was made with the observing programme both at the Cape and at Pretoria. It was very satisfactory that the *E*-region zero-point programme was completed in a year, thus providing the material for rounding off the first half of the standard magnitude programme on which the Observatory has been engaged for a long time.

As stated in the report for 1951, arrangements were made for an examination of the declination axis of the Victoria telescope, in consequence of which it was out of action during a great part of 1952. Temporary repairs were not satisfactory, the motion of the telescope being still very stiff, and it was decided to fit modern roller and thrust bearings. This was not completed before January 1953; but it was possible to use the instrument for short periods between the various stages. The motion of the telescope is now quite smooth and easy, but it was used on only 63 nights during the whole year as compared with 177 nights in 1951. The opportunity was taken during the periods when the instrument was out of action to remove from the pier the old and massive weight-driven clock which was superseded in 1950 by a comparatively small electric synchronous motor, and at the same time to renew much of the electric wiring and to fit a new slow-motion motor. The tube of the 24-in. telescope was shortened by three inches in preparation for the fitting of the new lens cell recently made by the firm of Cox, Hargreaves and Thomson.

The astrographic refractor was used on 178 nights—32 more than during the previous year—in spite of the fact that it was out of commission for about three weeks in October and November in connexion with the remounting of the photometric cameras. Since their return from Cambridge, they have been adapted to use standard 16 cm. × 16 cm. plate-holders and have been fitted with new exposing-shutters working in front of the lenses and with an extra long dew-cap fitted with internal diaphragms to keep out

* Report of Her Majesty's Astronomer at the Cape of Good Hope to the Secretary of the Admiralty for the year 1952. Pp. 16. (Cape of Good Hope: Royal Observatory, 1952.)

scattered sky light. Although the instrument behaves fairly well, its drive and clamping mechanism need a thorough overhaul; the dome does not turn very freely, and the axles and bearings of the wheels carrying it are badly worn and will soon require renewing. The 7-in. telescope, now that the "Bright Star Programme" is finished, is used for observing occultations, and also by Mr. W. P. Hirst, a local amateur, for the micrometric measurement of double stars; Mr. A. G. F. Morrisby also uses it for observing variable stars. The 6-in. telescope, still utilized by visitors and for observing occultations, has been used regularly by Mr. R. P. de Kock for observing long-period variable stars. The Tower telescope and the photoheliograph, as described in the 1951 report, continue to be used, the first for observing occultations and variable stars, and the second for taking photographs—two each day—of the sun. A new photoelectric photometer, which was built during 1952 and used for a time on the Victoria telescope, has been transferred to the astrographic telescope to replace the old and rather inefficient photometer that was built originally for the 7-in. telescope; this new photometer will be used for the "Bright Star Programme" already referred to.

Nearly half the report is included under the heading "Observations and Reductions", and comprises: meridian observations, photographic star positions and proper motions, the parallax programme, Radcliffe section, stellar photometry, photoheliograph, occultations and variable stars. Under each of these, full accounts are given of the progress during the year under consideration. In the section on stellar photometry, reference is made to the photometric cameras, which were not mounted on the astrographic refractor until November 1952, and were brought into use in December. An outline of the two short programmes for this instrument is given, the second of which is required to complete the work done at the University of Cambridge Observatories.

A reorganization of the time service and clock installation was begun in August; but much detailed work still remains to be done, although the major changes were completed by the end of 1952. All the telephone cables in the grounds have been completely renewed by the G.P.O., to whose "remarkable speed, efficiency and close cooperation throughout, the Observatory is deeply indebted", in the words of the director. The Observatory keeps a limited stock of chronometers and watches for issue to H.M. ships; in 1952 nine were issued and ten received. Meteorological work proceeded on the usual lines, continuous records being obtained of barometric pressure, temperature, humidity, wind direction and wind velocity on self-registering instruments.

Towards the end of the report reference is made to the jubilee meeting of the South African Association for the Advancement of Science, which was held in July and which brought a number of distinguished scientists to Cape Town. After the meeting, Prof. J. H. Oort gave a popular lecture under the auspices of the Board of Extra-Mural Studies of the University of Cape Town, and so great was the popular response to this lecture that, by request of the University, Dr. D. S. Evans gave a series of six evening lectures on modern astronomical problems, which were all very well attended. Earlier in the year an astronomical exhibit, organized by Dr. Evans, was shown in the Hall of Science at the van Riebeeck Festival Fair.

It is satisfactory to know that, in addition to the regular visiting days and the opening of the Observatory for inspection one afternoon a month, the 5-in. and 6-in. telescopes have been placed at the disposal of the Cape Centre of the Astronomical Society of South Africa for the entertainment of visitors. These evenings have proved so popular that there has always been a long waiting list for the admission permits.

EUROPEAN TIMBER TRENDS AND STATISTICS

In two United Nations publications, "European Timber Trends and Prospects"* and "European Timber Statistics, 1913–1950"†, the Food and Agriculture Organization of the United Nations has summarized information collected jointly by it and the Timber Committee of the Economic Commission of Europe; the second publication arises more or less out of the investigations contained in the first.

In the autumn of 1947, when the Timber Committee of the Economic Commission of Europe was first estab' hed, its purpose was to help European governmen.. to overcome, through concerted action, the acute timber shortage which was hampering European reconstruction. To a certain extent success was achieved, despite the temporary disappearance of the U.S.S.R. as a large source of soft-wood supplies and without aggravating Europe's dollar deficit through continuous heavy imports of North American timber. By 1949 the temporary equilibrium reached was precarious and obviously unstable, and war restrictions in the consumption of timber and paper were still in force. But the questions still remained of whether or not Europe was still faced with a timber shortage, and how would supply and demand of forest products develop over a longer span of years. The Committee therefore undertook a study of European timber production, consumption and trade, primarily to find answers to these questions, and its findings are jointly summarized in "European Timber Trends and Prospects", which is a monumental piece of research work. The resulting beliefs appear to be that by 1960 Europe may be deficient in timber unless she increases her own production by a "dynamic forest policy" of reafforestation and so forth, or imports larger amounts from North America and the tropical forests. It is open to doubt, taking into consideration the considerable period of time it takes trees to reach timber size, whether long forecasts are possible.

In the accompanying volume on "European Timber Statistics, 1913–1950" the periods covering the war years 1914–19 and 1939–45 have been excluded owing to the lack of adequate statistical information about them. This may seem to lessen the value of the inquiry somewhat since excessive fellings were made in the forests during the two World Wars, fellings which reduced subsequent consumption for a number of years. The volume is divided into three sets of tables, dealing respectively with production, trade

* European Timber Trends and Prospects: a Study prepared jointly by the Secretariats of the Food and Agriculture Organization of the United Nations and the United Nations Economic Commission for Europe. Pp. xvi+315. (Geneva: U.N.(F.A.O.); London: H.M.S.O., 1953.) 14 Swiss fr., 25*s.* or 3.50 dollars.

† European Timber Statistics, 1913–1950: Statistiques Européenes du Bois, 1913–1950. Pp. v+168. (Geneva: U.N.(F.A.O.); London: H.M.S.O., 1953.) 7 Swiss fr., 12*s.* 6*d.*, or 1.75 dollars.

and consumption. It is stated that the object of the investigation is an attempt to fill a need felt by the majority of those entrusted with the role of wood in the European economy or who have tried to grapple with the timber problem on a European scale. For the first time, it is claimed, an attempt has been made to arrive at figures for trade and production in wood and its products for every European country, and to bring them together in the form of a convenient reference. This aim appears to have been usefully achieved. The volume has an increased value as it is in both English and French, the former on the left-hand pages and the latter on the right—a most effective method of increasing its utility.

E. P. STEBBING

PARAMAGNETIC RESONANCE IN NEUTRON-IRRADIATED DIAMOND AND SMOKY QUARTZ

By DR. J. H. E. GRIFFITHS, J. OWEN and I. M. WARD

Clarendon Laboratory, Oxford

THE nature of lattice defects in neutron-irradiated diamond is a problem of current interest. These defects are known to cause changes in some of the physical properties[1] and give rise to a paramagnetic absorption spectrum. We have measured this spectrum in the temperature-range 20°–290° K., using wave-lengths of 1·2 and 3·1 cm. There are many closely spaced lines, of which two main types can be distinguished.

(*a*) There is an isotropic absorption line with spectroscopic splitting factor $g = 2{\cdot}0028 \pm 0{\cdot}0006$. Both the intensity and width increase with duration of irradiation, but are reduced after the diamond has been heated to about 1,000° C. (The intensity of the coloration produced by the irradiation varies in a similar way.) The line width, which after long irradiation is of the order of 100 gauss, decreases with temperature, being approximately half as big at 90° K. as at 290° K. This type of absorption line has also been observed in diamonds coloured by electron irradiation.

(*b*) There is an anisotropic spectrum consisting of lines symmetrically arranged about the type (*a*) line, and of the order a hundred times smaller in intensity. The intensity does not appear to be affected after heating to 1,000° C., and the line width is independent of temperature, being of the order of 5 gauss. This structure has been investigated in several Type 1 and Type 2 diamonds where the large central line had been reduced by heating. It is found that the positions in the spectrum of the most intense twelve of these anisotropic lines are identical in all the specimens that we have examined. They appear to arise from paramagnetic units in the crystal with electronic spin $S = 1$, the spin-levels being separated into a doublet and a singlet (separation $D = 0{\cdot}010$ cm.$^{-1}$) by a crystalline field of nearly axial symmetry. This axis is found to be parallel to one of the six edges of the fundamental carbon tetrahedron of the diamond lattice, so that there are six differently oriented units present, each giving two lines in the spectrum (see Fig. 1). The mean spectroscopic splitting factor is $g = 2{\cdot}0027 \pm 0{\cdot}0005$, and has a very small anisotropy given by $g_\perp/g_\parallel = 1{\cdot}00035 \pm 0{\cdot}00005$. For a general direction of the magnetic field the positions of the lines from each unit are given by the usual spin Hamiltonian $\mathcal{H} = \beta H.g.S + DS_z^2$, the constants having the values given above. Apart from these twelve lines, other smaller lines are also present, the intensities and positions of which in the spectrum are not found to be the same in all specimens.

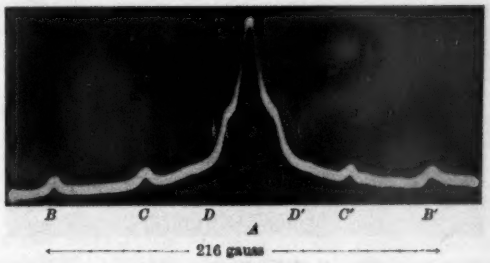

Fig. 1. Spectrum from an irradiated diamond with magnetic field H parallel to [1,1,0]
A, central type (*a*) line (reduced by heating); B and B', lines from one unit with axis parallel to H (that is, parallel to [1,1,0]); C and C', lines from one unit with axis perpendicular to H; D and D', superimposed lines from four units with axes inclined at 60° to H

A preliminary theoretical investigation of the magnetic properties of neutron-irradiated diamond, in which it is assumed that carbon atoms are knocked into interstitial positions leaving vacancies in the lattice, has been made by Pryce[2]. Although it is too early to give any detailed interpretation of the spectrum described above, a tentative explanation which would give the correct spins of $S = 1$ and the particular axes of distortion is that this spectrum arises from interstitial carbon atoms linked together in pairs.

The centres which are produced in quartz by X-irradiation, giving rise to the well-known smoky colour, appear to be of a different kind from those in diamond, and have been thought for some time to be connected with the presence of impurity atoms in the silica lattice (see, for example, Brown and Thomas[3]). We have investigated the paramagnetic resonance in irradiated natural crystalline quartz and have found that a few hours irradiation by either neutrons, electrons or X-rays gives rise to the same spectrum. Prolonged irradiation by neutrons gives rise to additional absorption lines which will not be discussed here. For quartz irradiated by X-rays, it appears that the intensity of paramagnetic absorption is directly proportional to the coloration produced; the lines are completely removed by heating the quartz to 350° C. The spectrum is also found in synthetic quartz, but is much reduced in intensity.

Measurements using wave-lengths of 1·2 and 3·1 cm. have been made at 90° K., the lines being very much broader at higher temperatures. The results indicate that there are six types of paramagnetic unit, each with electronic spin $S = \frac{1}{2}$ and the same principal g-values ($g_\parallel = 2{\cdot}06 \pm 0{\cdot}005$; $g_\perp = 2{\cdot}00 \pm 0{\cdot}005$), but with differently oriented axes of magnetic symmetry. Each of the six absorption lines appears to be subdivided into six lines of roughly equal intensity with an overall separation of about 28 gauss at both wave-lengths (see Fig. 2). It is possible that this is a hyperfine structure, which suggests that the magnetic centres involve electrons,

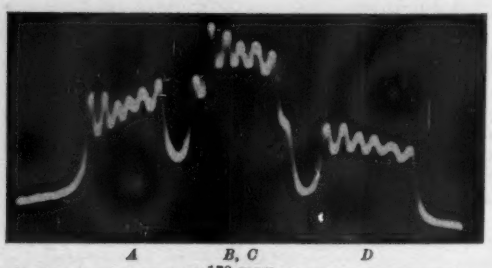

Fig. 2. Part of spectrum at 1·2 cm. from smoky quartz including four of the six blocks of absorption lines
A and *D*, separate blocks showing the subdivision into six lines. *B* and *C*, two blocks with their centres displaced by one 'hyperfine' space

moving in orbits closely associated with foreign atoms in the lattice, which have nuclear spin $I = 5/2$. The most likely impurity elements satisfying this interpretation are aluminium-27, manganese-55 and iodine-127, and of these aluminium is the most probable.

It is hoped to test this tentative explanation of the spectrum by measuring synthetic quartz into which known impurities have been introduced.

We would like to thank the Diamond Corporation, the Physics Department, University of Reading, the General Electric Company and the Atomic Energy Research Establishment, Harwell, for the loan and irradiation of specimens, and also Dr. A. H. Cooke, who first reported to us the presence of resonance lines in diamonds. [Dec. 18.

[1] Dugdale, R. A., *Brit. J. App. Phys.*, **4**, 334 (1953).
[2] Pryce, M. H. L., Diamond Conference, Oxford (1953).
[3] Brown, C. S., and Thomas, L. A., *Nature*, **169**, 53 (1952).

EXPERIMENTAL INDUCTION OF BUDS FROM FERN LEAF PRIMORDIA

By ELIZABETH G. CUTTER

Department of Cryptogamic Botany, University of Manchester

RECENT comparative and experimental studies of leaf morphology have aroused a renewed interest in the relationship between leaves and buds. In the fern *Dryopteris aristata*, Wardlaw[1,2] has shown that bud and leaf primordia are histologically identical, and that buds may be caused to develop at presumptive leaf positions when these are isolated from the shoot apex by a tangential incision. Similar preliminary experiments[3,4] on the isolation of young emergent leaf primordia resulted in the development of awl-shaped leaves of limited growth and approximately radial symmetry, with associated axillary buds. Further experiments reported below have shown that under certain conditions it is possible to cause such leaf primordia also to develop as buds. (Following the terminology of Snow and Snow[5], leaf primordia visible at the time of the operation will be called P_1, P_2, etc., P_1 being the youngest; primordia which were initially invisible but which developed during the course of the experiment will be called I_1, I_2, etc., I_1 being the first to arise.)

Leaf primordia of *Dryopteris aristata* were isolated from the shoot apex and adjacent primordia by four fairly deep incisions. The isolated plugs were rectangular in shape and were relatively large; the majority of the plugs were elongated in a direction tangential to the shoot apex (Fig. 1*A*), but a few were elongated radially (Fig. 1*B*). These operations were carried out on primordia P_1–P_4 over a period of ten months, from March to December 1953, and have resulted always in the development either of a bud or of a normal, dorsiventral, circinate leaf primordium. The results of the experiments are presented in Table 1. It was found also that, as in the case of Wardlaw's[1,2] experiments on the I_1 presumptive position, isolation of the primordium from the shoot apex by a single tangential incision was sufficient to cause its development as a shoot bud. Notwithstanding the marked seasonal metabolic changes known to occur[6] in the apex of *D. aristata*, neither the season of its collection nor the growth-rate of the apex had any effect on the development of the isolated leaf primordium.

Table 1. Developmental Analysis of Experimental Isolations of Leaf Primordia

Primordium isolated	Total No. of viable isolations	No. which developed as buds	No. which developed as leaves	No. which developed as leaves, or moribund leaves, with associated axillary buds
P_1	120	111	9	—
P_2	27	20	6	1
P_3	10	2	7	1
P_4	7	—	5	2

It is clear from these results that the youngest three leaf primordia, at least, are capable of development as buds if they are isolated from the influence of the shoot apex. While Table 1 gives a reliable indication of the ratio of buds to leaves which may be expected from isolations of P_1, in many cases the examples of P_2 and P_3 were chosen because their relatively flat appearance indicated that they might be capable of development as buds. The results for P_2 and P_3, therefore, do not give a reliable estimate of the proportion of buds to be expected from random isolations of these primordia.

From Table 2 it is evident that leaf primordia isolated at a late stage of the plastochrone yield a higher proportion of leaves than those isolated at an earlier stage. Careful observation of leaf ontogeny has shown that the distinction can be rendered more precise. A leaf primordium arises from the outgrowth of a group of equal prism-shaped cells of the apical meristem[4]; afterwards one of these cells, near the centre of the locus of growth, enlarges and grows

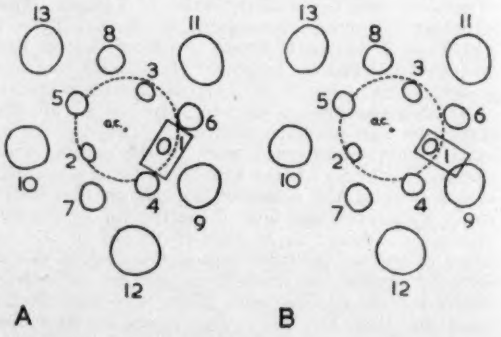

Fig. 1

Table 2. The Effect of the Stage of the Plastochrone attained at the Time of Isolation on the Subsequent Development of Isolated P_1 Primordia

Stage of plasto-chrone	Total No. of viable isolations	No. which developed as buds	No. which developed as leaves	Per cent buds	Per cent leaves
Early	37	36	1	97·3	2·7
Middle	58	56	2	96·6	3·4
Late	25	19	6	76·0	24·0

out, taking precedence over the other cells. Ultimately this cell becomes very much enlarged, and its lateral walls become convex; at this stage it is recognizable as the characteristic lenticular apical cell of the leaf of this species. Before a single cell has visibly taken precedence over the other cells of the primordium and has grown out from the surrounding tissue, a primordium is capable of development as a bud, but after a single cell has become dominant and is beginning to become lenticular in shape, the primordium is no longer able to develop as a bud and, under the conditions of these experiments, will develop as a normal, dorsiventral leaf primordium. The stage at which a primordium attains this condition is variable in different apices; this explains how some primordia are still capable of developing as buds at as late a stage as P_3. This has been confirmed by anatomical investigation. There must therefore be a close temporal relationship in this species between the irreversible physiological changes which impose upon a primordium dorsiventrality and a capacity for rapid but ultimately limited growth, and the formation of its apical cell. Such a relationship renders it possible to predict with a high degree of certainty which leaf primordia are capable of development as shoot buds under the prevailing experimental conditions.

Attempts were made to mark the centre, or, where visible, the apical cell of the primordium at the time of isolation with a free-flowing brand of indian ink, applied with a small paint brush from which the majority of the bristles had been excised. No toxic effects of the ink were observed. Due to technical difficulties, it was not always found possible accurately to mark the central cell of the leaf primordium, and any initial discrepancy between the mark and the centre of the primordium became magnified as a result of growth and cell division. It was invariably found, however, that the ink mark occupied the same position relative to the apex of the induced bud as initially it had done relative to the apex of the leaf primordium. It therefore seems certain that the apex of the isolated leaf primordium does give rise to the apex of the bud.

The first leaf primordium of the induced buds always arose on the longest axis of the isolated plug, and in cases where the primordium was symmetrically situated on the plug two leaf primordia frequently arose almost contemporaneously, approximately opposite to one another. On plugs of the type illustrated in Fig. 1*A*, the first leaf primordium arose more frequently on the P_4 side of the plug than on the P_6 side; that is, on the side where there is slightly more space, since the isolated P_1 primordium is situated slightly closer to P_6 than to P_4. Further experiments are necessary to establish the underlying cause. Normal spiral phyllotaxis usually was not established until after the inception of at least six leaf primordia; this is in agreement with observations on seedling apices of various angiosperms[5,7].

The vascular system of the induced buds was solenostelic; that of isolated primordia which developed as leaves was solenostelic at the base with normal leaf vascular structure distally[3,4]. No vertical contact was ever made with components of the shoot stele; this is probably the reason for the ultimately rather limited growth of both induced buds and isolated leaves.

It appears that the different results obtained in earlier experiments on the isolation of leaf primordia were due to a difference in the position of the cuts, which were made as close to the primordium as possible[3]. Spatial and nutritional effects are still under investigation and have not yet been fully considered. It will be of interest also to determine the exact depth of incision which is necessary to permit development of the primordium as a bud.

From these experiments and those of Wardlaw[1,2] it is apparent that, in *D. aristata*, leaf primordia are initially capable of development either as leaves or as buds, depending on the conditions operative upon them. This provides evidence against the existence of specific leaf- and bud-forming substances. Under normal conditions the primordia develop as leaves, determinate organs of dorsiventral symmetry and rapid growth, but it is possible to change their destiny by isolating them from some influence of the subtending shoot apex at a sufficiently early stage. Sussex[8] was able to induce centric leaves in the potato by isolating the I_1 presumptive position from the shoot apex, and leaves of radial symmetry have been observed in the course of other experiments[9–11], always associated with either destruction or attenuation of the shoot apex. From plants of *Osmunda regalis* which had been maintained under unfavourable conditions after destruction of the shoot apex, Lang[9] obtained leaves bearing lateral and terminal buds, in addition to cylindrical organs, and leaves which gave rise aposporously to prothalli at their tips. In some cases the tip of the leaf became transformed into a shoot bud. It appears, therefore, that the induction in the primordium of dorsiventral symmetry and of the biochemical conditions characteristic of leaf growth is initially due to factors extrinsic to the primordium itself and is a function of the active shoot apex, but the mechanism by which this is brought about is not yet understood.

The results of these experiments clearly provide some measure of support for the partial-shoot theory of the leaf developed by Arber[12,13] as a result of comparative studies of angiosperms.

I am indebted to Prof. C. W. Wardlaw for his guidance and encouragement throughout the investigation. This work was carried out during the tenure of a Berry Scholarship awarded by the University of St. Andrews.

[1] Wardlaw, C. W., *Nature*, **164**, 167 (1949).
[2] Wardlaw, C. W., *Growth* (supplement), **9**, 93 (1949).
[3] Wardlaw, C. W., *Phil. Trans. Roy. Soc.*, B, 233, 343 (1947).
[4] Wardlaw, C. W., *Phil. Trans. Roy. Soc.*, B, 233, 415 (1949).
[5] Snow, M., and Snow, R., *Phil. Trans. Roy. Soc.*, B, 221, 1 (1931).
[6] Frazer, H. L., *Ann. Bot.*, N.S., **10**, 391 (1946).
[7] Van Iterson, G., "Mathematische und Mikroscopisch-Anatomische Studien über Blattstellungen" (Jena, 1907).
[8] Sussex, I. M., *Nature*, **167**, 651 (1951).
[9] Lang, W. H., *Mem. and Proc. Manchester Lit. and Phil. Soc.*, **68**, 53 (1924).
[10] Snow, M., and Snow, R., *Phil. Trans. Roy. Soc.*, B, 225, 63 (1935).
[11] Wardlaw, C. W., *Ann. Bot.*, N.S., **9**, 383 (1945).
[12] Arber, A., *Biol. Rev.*, **16**, 81 (1941).
[13] Arber, A., "The Natural Philosophy of Plant Form" (Camb. Univ. Press, 1950).

LETTERS TO THE EDITORS

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Measurement of Length and Angle in Quantum Mechanics

I WISH to point out that in the accepted theory the association of operators and observations is very intricate precisely in the simplest cases. You give me a splinter of a diamond crystal. Its state function is to be an antisymmetric function of the co-ordinates x_k of the n carbon nuclei the specimen contains. Can this function give information on the *shape* of the splinter? The label k is not connected with any location, with any point of the crystal lattice! Let the splinter be needle-shaped. I can measure its length. What operator is associated with this measurement? We must remember that only operators *symmetric* with respect to all the x_k are meaningful.

The only answer I can find to the last question is this. Let $r_{kl} \geqslant 0$ be the distance between the k^{th} and the l^{th} carbon nucleus ($k \neq l$). Let F be a symmetric function of the $n(n-1)/2$ variables r_{kl}, the value of F being equal to the biggest of its arguments. (This does not contradict its symmetry; for example, for $n = 3$ we should have F a function of the three variables r_{12}, r_{23}, r_{31}, constant on the half-surfaces of certain cubes, its value being the edge of the cube.)

This function $F(r_{kl})$ might be associated with the measurement of the length of the needle. In order to account for the whole observed shape of a solid, the construction could be extended in an obvious way, by using as the arguments of F not the mutual distances, but the Cartesian co-ordinates of the nuclei with respect to the centre of gravity. But is this answer satisfactory?

In the case of a crystal, the elements of shape that interest us most are the angles between the various plane domains of its surface. The measurement of the angle between two crystal planes is certainly the one most frequently performed on a crystal concerning its external shape. Even an X-ray investigation of a single crystal is usually preceded by carefully orientating it with respect to a given frame; this amounts to angle measurements of a similar kind. For all these purposes no measurement of length in the crystal is required, nor is any usually made. It is hard to see how the accepted theory would associate a Hermitic operator with this very common kind of laboratory performance.

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Jan. 5.

Diffraction Gratings in Immersion

AT the London Optical Conference in 1950, it was suggested[1] that the resolving power R of diffraction gratings might be increased by immersing the grating in a medium of high refracting index μ_i. Thus:

$$R = \frac{2\,W \sin\alpha}{\lambda} \cdot \mu_i, \qquad (1)$$

where W is the ruled width of the grating and where α applies for the case of autocollimation of incidence and diffraction. This idea, which is a strict parallel to that of the immersion microscope, was further developed[2] in accordance with Figs. 1*a* and *b*.

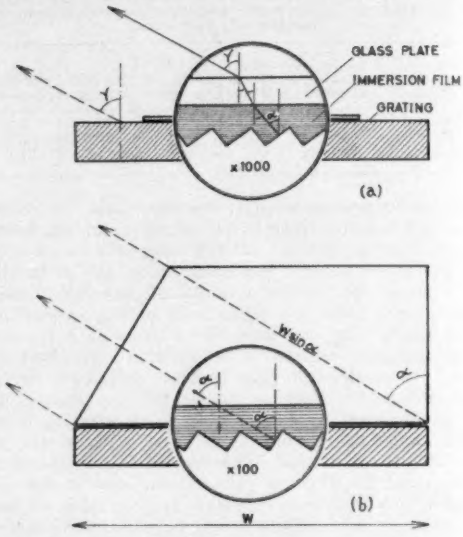

Fig. 1

If we bring a piece of coverglass into optical contact with a plane grating with an immersion film (Fig. 1*a*), two kinds of spectra can be observed: one produced by the uncovered grating, as indicated by the dotted line, and the other produced by the 'immersion'-grating. These two spectra will coincide in all orders in accordance with Snell's law of refraction. They will, however, exhibit great differences in intensity, as the immersion spectrum is produced at a steeper angle of incidence α than the angle of incidence γ occurring at the uncovered surface:

$$\sin\gamma = \mu_i \sin\alpha. \qquad (2)$$

Thus a grating characterized by a 'blaze' in an order m will have this blaze shifted into the range of $\mu_i m$ when it is used as an immersion grating. Striking illustrations of this effect were obtained from photographs of the grating surface. Thus a piece of coverglass, which was fastened to the grating by an immersion oil, appeared in bright or dark contrast to the uncovered part of the grating, when illuminated in different orders of monochromatic light.

Some experiments were also made with ruling gratings on transparent films of antimony trisulphide and zinc sulphide, evaporated in vacuum on the 'back' surface of plane glass plates, afterwards aluminizing the ruled surfaces for reflexion. These films of very high refractive indices ($\mu > 2$) were, however, very brittle, so that the grating surfaces soon began to crack. (The proper name "refraction grating" given earlier[2] refers only to this special application of the immersion principle with diffraction gratings.)

A second method of testing the immersion principle will now be reported. In the ordinary dense-ruled gratings, the blaze generally appears in the first or second orders of spectrum, corresponding to angles of incidence less than 20°. In the coarse-ruled gratings, however, the blaze sometimes appears at high angles of incidence $\simeq 60°$. When applying the method of immersion to a grating of this type, it is advantageous

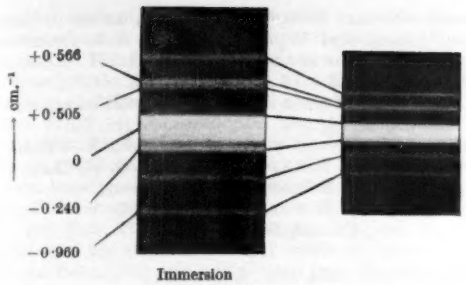

Fig. 2

to let the beam pass through a prism or a side facet in the glass plate as indicated in Fig. 1*b*. For simplicity we may assume that the refraction indices of the prism and the immersion oil are equal, otherwise the conditions of the system, Fig. 1*b*, must be treated in more detail. Fig. 2 illustrates the considerable gain in the dispersion and resolving power of a plane grating, $W = 93$ mm., when it was immersed in α-bromnaphthalene and covered by a 30°/60° dense flint glass prism. The perfect resolution of the narrow doublet 0·566/0·505 cm.⁻¹ in the hyperfine structure of the mercury line λ 4358 indicates that the spectroscopic resolution is well above 400,000.

Further details of this investigation will appear in *Arkiv för Fysik*.

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Dec. 14.

[1] Hulthén, E., Proc. London Opt. Conference 1950, p. 111.
[2] Hulthén, E., *Ark. Fys.*, 2, 439 (1950).

Use of High Contrast in the Photography of Interference Fringes

In a recent communication, Hough and Goldsmith[1] have described a method of increasing the sharpness of interference fringes by high-contrast photography with controlled exposure. Although the technique does not appear to be widely known and I have no knowledge of any published material on the subject, the method is not new and has been in use here for a number of years.

For the case of infinite contrast, which is the only case in which the widths of dark and light fringes may be adequately defined, a curve relating black/white ratio to exposure for a single photographic process may be obtained by considering the intersection of the curves $I = \sin^2 x + A$ (light intensity) and $I = B$ (threshold at which the dark–light transition on the plate occurs), where I is light intensity, x is distance perpendicular to fringe direction and A and B are constants depending on fringe visibility and exposure. The lengths of the intercepts of $I = B$ below and above $I = \sin^2 x + A$ give the widths of dark and light fringes respectively. Fig. 1 shows a curve for 100 per cent fringe visibility ($A = 0$).

Experimentally it has been found that, over the exposure range 0–7, results are in good agreement with theory; but above this value measurement of fringe-widths becomes difficult, and black/white ratios greater than 5·5 are difficult to obtain. In order to obtain the best results in the over-exposure region,

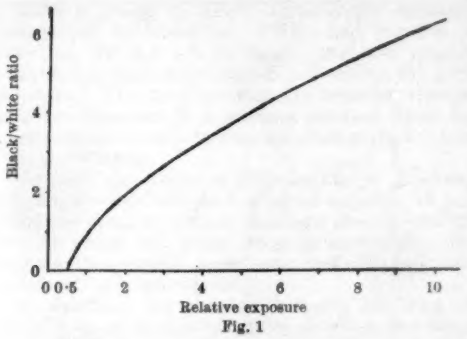

Fig. 1

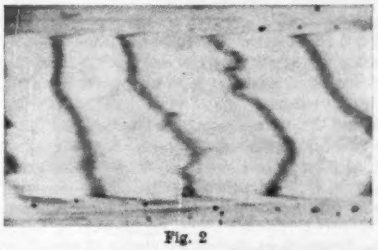

Fig. 2

two points require attention. First, developer fog must not be allowed to appear; the use of an efficient stop-bath after development is useful for this. The second condition is that the fringe-spacing must not be too small. Using Ilford *R*.40 plates, a separation between fringes of 2 mm. on the plate appears to be necessary for the best results. With a fringe-spacing of 0·5 mm. a black/white ratio of 3·5–4 seems to be the best obtainable.

Where a double photographic process (negative and print) is used, the following technique gives good results. The negative is given an exposure of about 4 and developed to only a moderately high contrast. By printing on a contrasty material with minimum exposure, a final result with white/black ratio about 6 may be obtained.

While this type of process can give much more accurate results than are normally expected from double-beam interferometry, some care must be exercised to prevent errors due to uneven illumination. A typical interferogram is reproduced herewith (Fig. 2).

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[1] Hough and Goldsmith, *Nature*, 172, 1105 (1953).

Ferroelectric Structure of Potassium Dihydrogen Phosphate

Slater's theory[1] of the origin of the ferroelectricity shown by potassium dihydrogen phosphate below 120° K. is based on the assumption that the proton of the O—H—O bond is situated in a double potential well. Above the Curie point, the proton is not permanently located in either well and moves between the two, giving the structure non-polar tetragonal symmetry. Below the Curie point the proton positions are ordered in accordance with the polar orthorhombic symmetry.

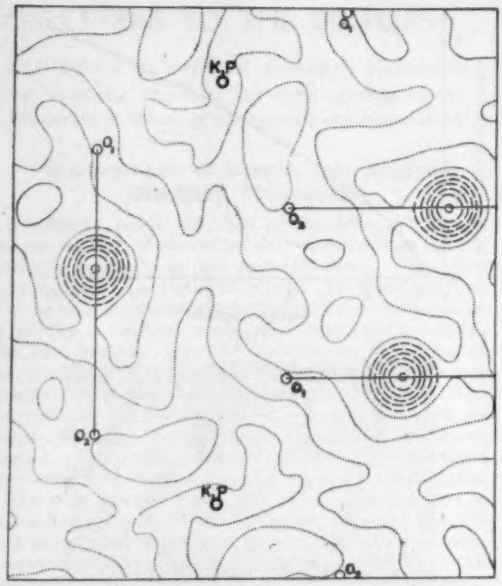

Fig. 1. Projection on (001) of the density of neutron scattering due to hydrogen atoms in potassium dihydrogen phosphate at − 180° C. Contours are drawn at intervals of 50 units. Broken lines are negative contours and the zero contour is shown dotted; no positive contours appear. The small circles mark the positions of the potassium, phosphorus and oxygen atoms

In a recent paper[2], we have discussed the structure at room temperature of potassium dihydrogen phosphate as determined by neutron diffraction. We have shown that the proton distribution is elongated along the O—H—O bond; but it is not possible to decide whether this is due to the existence of a double potential well or to a normal anisotropy of thermal agitation. If the former is in fact true, then we have found that the two minima are displaced by about ± 0·18 A. from the centre of the O—H—O bond.

We have now obtained some results on the structure in the ferroelectric state, the crystal being maintained as a single domain by means of an electric field. We find that here the hydrogen atom is situated asymmetrically between the oxygens, in an ordered arrangement to satisfy the *Fdd* symmetry as supposed by Slater. A projection of scattering density on the (001) plane is shown in Fig. 1; this can be contrasted with Fig. 10 of our earlier paper[2], which shows the same portion of the structure at room temperature. The projection shows the Fourier synthesis of hydrogen atoms only, as obtained from the quantities $F_{obs.} - F_{KPO}$, where $F_{obs.}$, F_{KPO} are respectively the observed structure factors and those due to potassium, phosphorus and oxygen calculated from the positions of these atoms given by a direct synthesis of $F_{obs.}$. For convenience the positions of these atoms are marked by circles in Fig. 1. The hydrogen atom is displaced by 0·21 A. from the centre of the O—H—O bond, the symmetry being such that throughout a single domain all the hydrogens are displaced towards, say, 'upper' oxygen atoms, O_1, of PO_4 groups in accordance with Slater's model. On reversing the electric polarization, they are all displaced towards 'lower' oxygens, O_2.

We find no significant movement of the oxygen atoms from their room-temperature positions in the *xy*-plane. If there is no substantial departure of the O—H—O bond from the horizontal, as seems likely from Frazer and Pepinsky's X-ray measurements[3], it follows that the two portions of the O..H....O bond will be 1·04 and 1·45 A. respectively.

Full details of these investigations will be presented in due course.

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Harwell,
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Nov. 13.

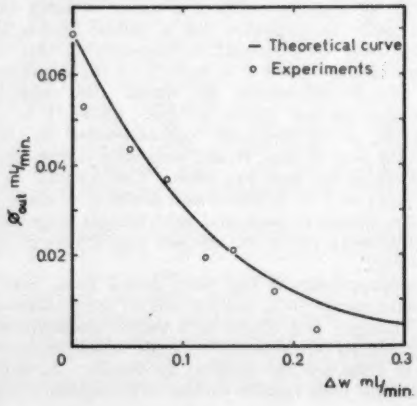
[1] Slater, J. C., *J. Chem. Phys.*, **9**, 16 (1941).
[2] Bacon, G. E., and Pease, R. S., *Proc. Roy. Soc.*, A, **220**, 397 (1953).
[3] Frazer, B. C., and Pepinsky, R., *Acta Cryst.*, **6**, 273 (1953).

Permeation of a Membrane in the Presence of Water-Flow induced by Hydrostatic Pressure

The present status of the quantitative theory of membrane transport processes in the absence of water-flow has been almost fully verified by the available experimental evidence. It is also a fact that in many artificial and biological membrane systems the effect of the water-flow, though undoubtedly present, can be neglected because of its small size. In other membrane systems this may not be so. It should be emphasized that the mere knowledge of rate of flow of a volume of water through a certain area does not give the velocity of the water-flow in the membrane.

In the flux equation, the influence of net solvent-flow can be expressed as an additive flux term equal to the velocity of water-flow times the concentration of the component studied at the membrane point considered[1]. The integration of the general equation describing the simultaneous operation of diffusion forces, electrical forces and the effect of fixed membrane charges as well as net solvent flow forces remains to be done. Manegold and Solf[1] solved the equation for an uncharged particle in a special case by employing the relation given by Hertz[2]. A solution for the general case, omitting only the effect of fixed membrane charges, has been suggested by Teorell[3]. In the interesting case where the ratio between influx and outflux is considered, solutions were given by Ussing[4] and Teorell[5].

Little attention has been given to an experimental approach to the phenomena[1]. In order to try to verify the theoretical statements, the following experiments have been carried out. In a dual diffusion



chamber system, one compartment was closed and connected to a constant-pressure device. A fairly permeable cellulose filter-membrane (effective area for heavy water diffusion about 30 per cent) separated the two compartments. A constant known flow of water could be obtained and the permeation of a test substance against the flow could be measured. The accompanying graph shows the result for deuterium-labelled water as the test substance. The total flux of water against the mass flow is plotted against the net flux, which, in this case, is equal to the velocity of the streaming water times the area available for flow. The curve is plotted from the relation :

$$\Phi_{out} = \frac{\Delta w}{\exp\,(\Delta w \,.\, \delta/ARTu') - 1},$$

where Φ_{out} is the total flux of water out, Δw is the net flux of water, A is the area available for flow, R the gas constant, T the absolute temperature and u' the mobility of the water molecule in the membrane, in this case taken to be equal to D_w/RT, where D_w is the free diffusion coefficient of water in water. δ is equal to the membrane thickness. The experimental observations seem to follow the theoretical curve quite satisfactorily (see figure).

A full report of these experiments and others in progress will be published later.

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University of Uppsala. Nov. 6.

[1] Manegold, E., and Solf, K., *Kolloid-Z.*, **59**, 179 (1932). Williams, J. W., and Cady, L. C., *Chem. Rev.*, **14**, 131 (1934). Bloch, I., *Bull. Math. Biophys.*, **8**, 21 (1946). Rashevsky, N., "Mathematical Biophysics" (rev. edit., Chicago, 1948). Ussing, H. H., *Acta Physiol. Scand.*, **19**, 43 (1949). Teorell, T., *Z. Electrochem.*, **55**, 460 (1951).

[2] Hertz, G., *Phys. Z.*, **23**, 433 (1922) ; *Z. Phys.*, **19**, 35 (1923).

[3] Teorell, T. (to be published).

[4] Ussing, H. H., in F. F. Nord, "Advances in Enzymology", **13** (1952).

[5] Teorell, T., in "Progress in Biophysics", **3** (London, 1953).

Sidereal Correlation of High-Energy Cosmic Rays

EXTENSIVE air showers have been recorded at Auckland (altitude 40 m.) during the period February 1951–February 1952 inclusive, with three counter trays each of sensitive area 2,360 cm.^{2} placed at the corners of an equilateral triangle with 4 m. sides. About 3×10^5 events have been recorded. Averaged over the year, the results show a solar diurnal variation of $1{\cdot}46 \pm 0{\cdot}16$ per cent (first Fourier amplitude with statistical probable error), with the maximum at $2{\cdot}9 \pm 0{\cdot}4$ hr. local solar time. This correlates well with temperature.

When the number of showers occurring in half-hourly intervals of sidereal time is averaged over the year, the figures show a sidereal variation with first Fourier amplitude $1{\cdot}06 \pm 0{\cdot}16$ per cent with the maximum at $19{\cdot}3 \pm 0{\cdot}6$ hr. local sidereal time. This result is similar to the Fourier amplitude of $0{\cdot}39 \pm 0{\cdot}13$ per cent with a maximum at $22 \pm 1{\cdot}3$ hr. local sidereal time obtained by Daudin and Daudin[1] in 1951 at the Pic du Midi for extensive air showers recorded with a different arrangement of counters.

A seasonal variation in the solar diurnal effect would give an apparent sidereal effect when the results are expressed in sidereal time and averaged over the year. In this case, provided the solar seasonal effect is the same in the southern as in the northern hemisphere, we would expect the apparent sidereal variation obtained in the two hemispheres to differ in phase by 180°. In fact, the variations observed at Auckland (lat. 37° S.) and the Pic du Midi (lat. 43° N.) are in phase, and the maxima coincide in local sidereal time almost within the probable error. This gives grounds for believing that the variation observed is a genuine sidereal effect and is not a residuum due to seasonal changes in the solar diurnal variation.

Although the times of the maxima at Auckland and the Pic du Midi do not agree exactly, at both places the local maximum coincides closely with the time at which the Milky Way is overhead. This suggests that cosmic rays come preferentially from regions of high star density.

At Auckland the maximum is not far from the time (18 hr. local sidereal time) at which the centre of the Galaxy crosses the meridian. The declination of the galactic centre is $-26°$. This means that it passes daily within 11° of the vertical at Auckland, but only within 69° of the vertical at the Pic du Midi. Any effect due to cosmic rays coming from the central region of the Galaxy should therefore be much stronger in Auckland than in Europe. This accords with the fact that our sidereal amplitude is nearly three times as large as that obtained at the Pic du Midi. The results therefore indicate that more high-energy cosmic rays are observed when the centre of the Galaxy is overhead.

We cannot reconcile these results with those of Ballario, Brunelli, de Marco and Martelli[2], who observed dense showers on the Testa Grigia for a period of three months and obtained a maximum at about 10 hr. Central European Time, which we find corresponds to 5 hr. local sidereal time.

One of us (J. R. S.) is indebted for a fellowship to the University of New Zealand Research Committee, which also gave a grant covering the major cost of the apparatus.

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Dec. 11.

[1] Daudin, A., and Daudin, M. J., *C.R. Acad. Sci., Paris*, **234**, 1551 (1952).

[2] Ballario, C., Brunelli, B., de Marco, A., and Martelli, G., *Nuovo Cim.*, **8**, 587 (1951) ; see also *Phys. Rev.*, **83**, 666 (1951).

Motion of the Storm-*D* Regions

W. R. PIGGOTT[1] has reported coherent variations with longitude which he interprets as motion of the "storm-*D* regions" once around the earth in 48 hr. This result is based on the data of about three years from each of six vertical-incidence ionospheric stations. Work at the National Bureau of Standards, however, based on ionospheric data tabulations from seventeen stations for the four years, 1949–52, does not support the hypothesis of coherent motion of such regions.

Reference will be made here to (per cent) 'probability of blackout' rather than to storm-*D* regions. Diurnal variation of blackout probability is determined by counting the number of instances (at each hour for the four-year period) of excessive absorption. In these cases the letter B is the standard symbol used to replace a numerical value for all the ionospheric parameters normally scaled : $f0F2$, $h'F2$, $f0F1$, $h'F1$, $f0E$, $h'E$.

Blackout may often be a misnomer, since the no-echo conditions can also arise if the equipment lacks

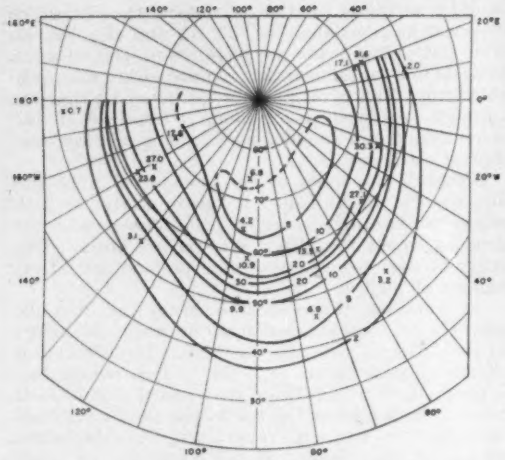

Fig. 1. Average probability (per cent) of blackout (A_0)

sensitivity and if absorption is only moderate. Moreover, Watts and Brown[2] have shown recently that at Washington, for example, 'no-echo' in the 1–25 Mc./s. range may be accompanied by F-layer reflexions with $f0F2$ less than 1 Mc./s., that is, at times of extremely low absorption. In general, it is impossible to differentiate among the three conditions: (1) blackout, (2) low sensitivity with moderate absorption, (3) $f0F2$ less than 1 Mc./s., by use of the tabulation sheets alone. The no-echo conditions, due to any of the three causes, is the subject of this communication, but the term 'blackout' will be used throughout. It is assumed that data from different stations are directly comparable.

The diurnal curves may be approximated (in general, quite closely) by the constant term and first harmonic of a Fourier series: per cent probability of blackout $= A_0 + C_1 \cos 15(t - \varphi_1)$, where A_0 is average per cent probability, C_1 is amplitude (per cent) of the first harmonic of the diurnal variation, φ_1 is time (in hours) at which the first harmonic reaches a maximum (φ_1, of course, may be expressed in local time for each station or in universal time).

Contour plots of A_0 (Fig. 1), C_1 (Fig. 2) and φ_1 (Fig. 3) are shown. The minimum shown on the plot for A_0 (or C_1) over North America, north of the auroral zone, is perhaps surprising; but its existence has long been suggested by the relative ease of maintaining radio communications inside the auroral zone. A recent study[3] of continuous-wave field-strength data gives additional evidence. The presence of this minimum suggests that rotation about the geographical pole is not likely, although such motion, possibly about the dip pole, is not ruled out.

The φ_1 plot (Fig. 3) does not suggest motion of the sort proposed by Piggott, nor does it suggest motion of any sort except that which is apparent in the case of any phenomenon depending primarily on local time. More important, however, is the fact that no simple longitudinal motion can account for the large, relatively complex latitude variations of

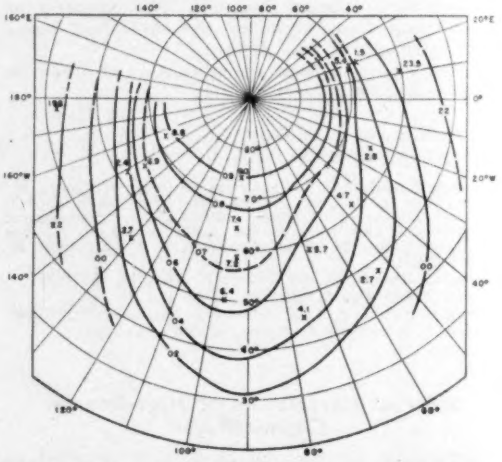

Fig. 3. Time (L.M.T.) of maximum probability of blackout (φ_1)

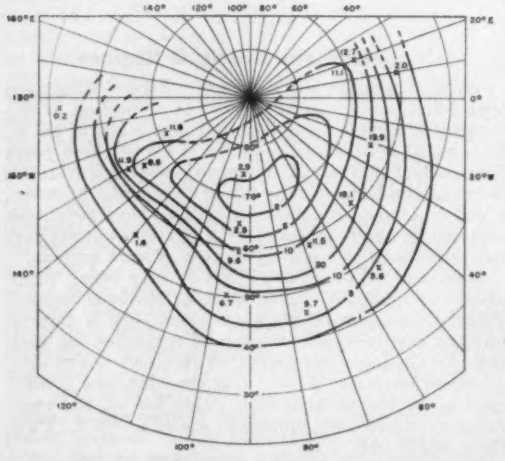

Fig. 2. Amplitude of diurnal variation of probability (per cent) of blackout (C_1)

A_0 and C_1. Motion, in a study of this kind, should be shown by comparison of plots of equal probability contours for successive hours of universal time: that is, the chart for 0000 G.M.T. should differ from that for 0100 G.M.T., etc., in such a way that speed and direction of the motion can be determined. Plots of this kind have been attempted, but appear to have little meaning and do not exhibit the motion suggested by Piggott.

It is concluded that a 48-hr. rotation of the storm-D regions is not indicated.

There is a large seasonal variation in blackout probability as well as variations with magnetic disturbance. These, as well as a more detailed account of the work referred to above, are being incorporated in a paper now in preparation.

Vaughn Agy

National Bureau of Standards,
Washington 25, D.C. Dec. 17.

[1] Piggott, W. R., *Nature*, 171, 124 (1953).
[2] Watts, J. M., and Brown, J. N., International Scientific Radio Union, Ottawa, October 5–8, 1953 (accepted by *J. Geophys. Res.* for publication in March 1954).
[3] Agy, V., International Scientific Radio Union, Ottawa, October 5–8, 1953 (accepted by the *J. Geophys. Res.*, for publication in June 1954).

Reduction in the Loss Factor of Certain Ceramics by Heat Treatment

It has been suggested by Breckenridge[1] that one of the main reasons for the absorption of energy in a.c. fields by alkali halide crystals is the presence in these crystals of pairs of associated lattice defects on adjacent sites. Breckenridge carried out measurements on various halide crystals, and he found in some cases that it was necessary to heat-treat a crystal at a temperature within 25° C. of its melting point, following this treatment by fairly rapid cooling, in order to produce a sufficient number of lattice defect pairs for the energy absorption to be measurable.

This suggested to me that it might be worth while to attempt to reduce the dielectric losses in steatite, forsterite and other ceramics by a prolonged heat treatment at a temperature well below the firing temperature of the ceramics. The heat treatment was chosen quite arbitrarily as 60 hr. at 1,000° C. The values of dielectric constant (K) and the tangent of the loss angle (tan δ) were determined at 10 cm. before and after heat treatment. Some of the results obtained are given in the accompanying table.

Ceramic	Before heat treatment		After heat treatment	
	K	tan δ	K	tan δ
A	5·8	15×10^{-4}	5·8	4×10^{-4}
B	6·8	6×10^{-4}	6·8	4×10^{-4}
C	6·1	4×10^{-4}	6·2	9×10^{-4}
D	6·6	7×10^{-4}	6·6	1×10^{-3}
E	6·2	5×10^{-4}	6·2	8×10^{-3}
F	6·8	2×10^{-4}	6·3	9×10^{-3}
G	6·0	2×10^{-3}	6·0	4×10^{-4}
H	6·3	1×10^{-3}	6·2	4×10^{-4}
I	6·3	7×10^{-4}	6·1	2×10^{-4}
J	5·4	2×10^{-3}	5·0	2×10^{-4}
K	5·4	1×10^{-3}	5·6	3×10^{-4}

Of these ceramics, *A* is a British commercial low-loss steatite ceramic, the remainder are materials made in the British Thomson–Houston Research Laboratory. Ceramics *B–E* are forsterite, *F* is a wollastonite material and the remainder are steatites. The table shows that in the majority of cases the heat treatment has caused a reduction in the value of tan δ, although in one case an increase was observed. This is to be expected in view of the arbitrary way in which the heat treatment was chosen. It should be noted that many of the values of tan δ quoted in the table are much lower than those previously quoted for ceramics of similar chemical composition. It seems likely that this type of heat-treatment process will make possible the commercial production of ceramics having much better loss properties than those hitherto available[2].

It is realized that, although the heat-treatment experiments were suggested by Breckenridge's work, it does not follow that the effect observed is caused by a reduction in the number of lattice defect pairs; it may well be that it is caused mainly by devitrification of the glassy phase in the ceramics. This point can only be settled by further experiments. To study the effect completely, it would also be necessary to make measurements over a considerable frequency-range and perhaps also over a range of temperature.

I am indebted to Miss J. E. J. Dods, who prepared the ceramics, and to Mr. J. H. B. Baker, both of this laboratory, who made the dielectric measurements; and also to Mr. L. J. Davies, director of research, for permission to publish this communication.

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[1] Breckenridge, R. G., *J. Chem. Phys.*, **16**, (10), 959 (1948).
[2] Brit. Pat. Applic. No. 23298/53.

Adsorption of Prostatic Phosphatase on Ion-exchange Resin

In recent years the proteins cytochrome *c*[1], ribonuclease[2], lysozyme[3], and hæmoglobin[4] have been successfully chromatographed on the carboxylic acid ion-exchange resin '*IRC* 50'. Experiments with proteins on the sulphonated polystyrene ion-exchange resin 'Dowex 50' have also been reported[5].

In the only case where an enzyme has been separated from a crude extract by the use of a column of '*IRC* 50'[2], the enzyme studied seems to be the only one to be adsorbed on the resin, while most of the other proteins pass right through the column. The fact that proteins often are not adsorbed on ion-exchange resins has also been utilized for desalting of proteins[3]. When, however, a protein can be adsorbed on—and later desorbed from—an ion-exchange resin the procedure might offer a fairly selective, yet mild and convenient method of purification.

This communication describes a partial purification of seminal prostatic phosphatase by adsorption on 'Dowex 50' and elution with a *p*H gradient. The principle of gradient elution has been outlined earlier[6]. The method is carried out here in such a way that an alkaline buffer will continuously replace the more acid starting buffer and thereby slowly change the *p*H of the eluting agent.

The enzyme solution used was obtained from normal human semen in the following way. The semen was diluted five times with 0·9 per cent sodium chloride solution and centrifuged at 2,000 *g* for 15 min. in order to remove the spermatozoa. The remaining solution was dialysed against a 0·2 *M* sodium acetate buffer of *p*H 5·4 (in the following referred to as the acetate buffer).

The phosphatase activity was determined at *p*H 5·5 according to Bessey *et al.*[7], using *p*-nitrophenyl phosphate as substrate.

The resin used was 'Dowex 50– × 8', 200–400 mesh, pretreated according to Moore and Stein[8] and finally washed with the acetate buffer. This pretreatment is essential—otherwise the enzyme is adsorbed so strongly that it cannot be eluted. After an experiment the column may be regenerated by washing with 1 *N* sodium hydroxide.

Most of the experiments have been performed on a small scale, the dimensions of the column being 8·0 cm. × 0·55 cm. The temperature was kept at 4° C. Usually, 0·3 ml. enzyme solution was applied to the column, the mixing chamber (volume 1·2 ml.) was filled with the acetate buffer and the open top chamber with a Palizsch's borate buffer of *p*H 7·3. The fraction collector used here shifted the tubes every 18 min., and the mean volume of the fractions was about 0·5 ml., although varying considerably during each experiment.

Fig. 1 gives the results of an experiment carried out as described above. The full line represents the

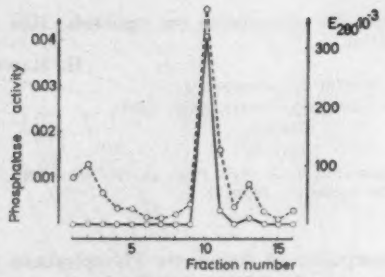

Fig. 1. Small-scale experiment with prostatic phosphatase on a column of 'Dowex 50'. Full line represents phosphatase activity in moles of substrate split during 30 min. at 37° C. Dashed line represents extinction at $\lambda = 280$ mμ

phosphatase activity and the broken line the extinction for ultra-violet light ($\lambda = 280$ mμ). As can be seen, the enzyme comes out as an extremely narrow zone and all the activity is collected in one fraction. About 75 per cent of the activity of the starting material is recovered.

The nitrogen concentration per unit activity of the active fraction shows that this chromatographic procedure gives at least a five-fold purification of the enzyme.

There are some difficulties in estimating the inactive protein material from the column. Using ultra-violet extinction, there is the risk of interference from low-molecular resin material which may be displaced from the column by proteins and therefore may appear in the eluate despite all the pre-washings. The Folin reagent was tried but gave unreasonable figures. Kjeldahl analysis has been used, but in most of the fractions (with the exception of that containing the enzyme) the concentration of nitrogen is too low to permit accurate determinations. However, both the ultra-violet extinction measurements and the Kjeldahl determinations show that some of the inactive material passes readily through the column whereas a large part remains on the resin.

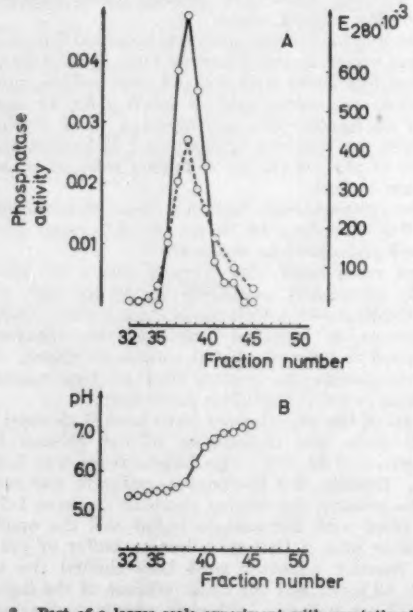

Fig. 2. Part of a larger scale experiment with prostatic phosphatase on a column of 'Dowex 50'. (*A*) Enzyme activity in moles of substrate split during 30 min. at 37° C. (full line), and the ultra-violet extinction (dashed line). (*B*) *p*H values for the corresponding fractions

Fig. 2 shows part of the results from an experiment performed on a scale fifty times greater than the previous one. The activity and ultra-violet extinction curves for the enzyme zone are shown in Fig. 2 *A*, while Fig. 2 *B* gives the *p*H values for the corresponding fractions. The interval between the shifts of the tubes was the same as before (18 min.). The volumes of fractions 35 and 45 were about 10 ml. and 6 ml. respectively.

It is to be expected from the method that a zone will appear near the maximum of the slope of the gradient. This can also be seen from a comparison of Fig. 2*A* and 2*B*, which shows that most of the enzyme is eluted between *p*H 5·5 and 6·5. The ultra-violet extinction measurements and Kjeldahl determinations indicate that some inactive material follows directly after the enzyme. A buffer system with a larger buffer capacity in the effective *p*H region would therefore be expected to give still better separations.

London and Hudson[9] have recently reported a purification of the prostatic acid phosphatase starting from prostate glands. One of the preparative steps they used was adsorption on calcium phosphate gel, which gives a two-fold purification. It is difficult at present to compare the purity of their enzyme with that obtained here after adsorption on 'Dowex 50'. In any event, it is felt that this adsorption procedure will be a useful complement to other preparative methods.

The work is being continued, and full accounts will be published elsewhere. I wish to thank Prof. A. Tiselius for his interest in this work.

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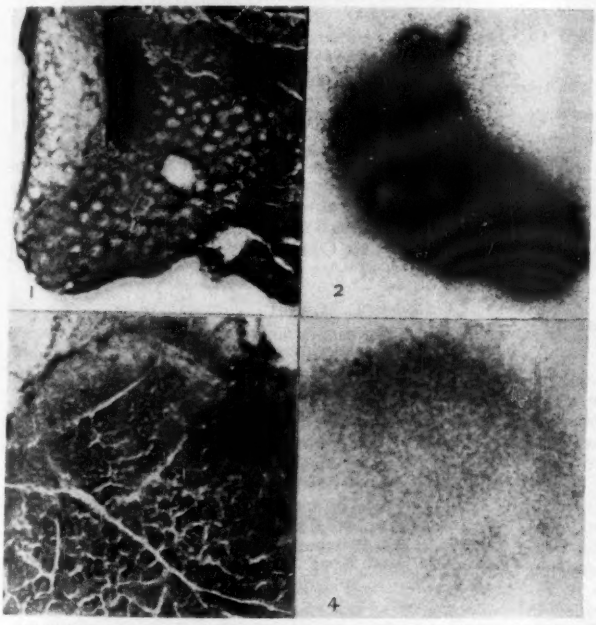
[1] Paléus, S., and Neilands, J. B., *Acta Chem. Scand.*, **4**, 1025 (1950).
[2] Hirs, C. H. W., Moore, S., and Stein, W. H., *J. Biol. Chem.*, **200**, 493 (1953).
[3] Tallan, H. H., and Stein, W. H., *J. Biol. Chem.*, **200**, 507 (1953).
[4] Boardman, N. K., and Partridge, S. M., *Nature*, **171**, 208 (1953).
[5] Sober, H. A., Kegeles, G., and Gutter, F. J., *J. Amer. Chem. Soc.*, **74**, 2734 (1952).
[6] Alm, R. S., Williams, R. J. P., and Tiselius, A., *Acta Chem. Scand.*, **6**, 826 (1952).
[7] Bessey, O. A., Lowry, O. H., and Brock, M. J., *J. Biol. Chem.*, **164**, 321 (1946).
[8] Moore, S., and Stein, W. H., *J. Biol. Chem.*, **192**, 663 (1951).
[9] London, M., and Hudson, P. B., *Arch. Biochem. and Biophys.*, **46**, 141 (1953).

Radioautographic Studies of the Digestive Tracts of Rats injected with Inorganic Sulphate labelled with Sulphur-35

Bélanger[1] recently reported the presence of sulphur-35 in the neck cells of the gastric glands of the rat following the administration of sulphuric acid labelled with sulphur-35 by subcutaneous injection. We wish to report that we made similar observations during the course of a radioautographic study of the distribution of sulphur-35 in the rat following the administration of radioactive inorganic sulphate. The techniques employed in this work and some of the results obtained have already been reported[2]. Sodium sulphate labelled with sulphur-35 was administered to rats by intraperitoneal injection,

and after various intervals the animals were killed, tissues were removed and contact radioautographs were prepared. Four hours after dosing there was considerable accumulation of sulphur-35 in the necks of the gastric glands, whereas radioactive material was absent from that part of the stomach lined with stratified squamous epithelium. More intense radioautographs were obtained from the intestinal glands (crypts of Lieberkühn). The most striking localization of sulphur-35, however, was observed in the small mucus-secreting salivary glands which lie in relation to the masseter muscle and are presumably posterior members of the molar group (Figs. 1 and 2). These results were in marked contrast to those obtained from the adjacent parotid gland present in the same sections, where the intensity of the radioautograph



(1) Section, 50 μ thick, of a mucus-secreting salivary gland from a 190-gm. rat injected intraperitoneally 4 hr. previously with sodium sulphate labelled with sulphur-35 (approx. 2 μc. of sulphur-35 per gm. body-weight). Hæmatoxylin and eosin. (2) Corresponding contact radioautograph. Both × 80. (3) Section, 50 μ thick, of the parotid gland of the same rat. Hæmatoxylin and eosin. (4) Corresponding contact radioautograph. Both × 80

was in general very low, and was less for the actual glandular tissue than for the capsule (Figs. 3 and 4). Other mucus-secreting salivary glands have not yet been investigated.

The distribution of sulphur-35 observed in these experiments suggests strongly that it was secreted as sulphomucopolysaccharide. If this proves to be so, inorganic sulphate labelled with sulphur-35 should serve as a useful tool for investigating the distribution and activity of mucus-secreting cells.

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[1] Bélanger, L. F., *Nature*, **172**, 1150 (1953).
[2] Davies, D. V., and Young, L., *J. Anat.*, **87**, 448 (1953), and also in the press.

Detection of Fingerprints by the Ninhydrin Reaction

In connexion with some recent legal proceedings, a new method for detecting fingerprints has been discovered by one of us (S. O.). The method involves the well-known ninhydrin test for amino-acids, often used in chromatography. In this method, fingerprints on paper have always been considered a great nuisance, and one is often recommended to use forceps "to avoid fingerprints"[1]. In our opinion, the new method will be most suitable for detecting fingerprints on paper and similar materials. Some of the results have a wider interest, and a brief report on the new application of ninhydrin is therefore presented.

When handling a paper, a person may leave his fingerprints on it, depending on many factors such as physiological conditions, time of contact between the fingers and the paper and other unpredictable circumstances. A spontaneous fingerprint contains 98·5–99·5 per cent water, the rest being organic and inorganic compounds. Normally, the water will evaporate, leaving the rest as a fingerprint pattern containing fats, salts, amino-acids, etc. The last group of substances gives the well-known reaction with ninhydrin. Since perspiration contains water-soluble amino-acids (at least ten amino-acids have been found[2]) a moist finger or a moist paper is necessary if fingerprints on paper are to be made visible by the ninhydrin reaction.

Fingerprints are developed by spraying the paper with a 0·2 per cent solution of ninhydrin in acetone, followed by heating the paper in an oven at 80° C. for a few minutes. This initiates the process, and the strongest marks become visible. The pink colour becomes more intense with time, and new marks appear as the developing process matures. Details seem to have a maximum distinctness a day or two after the ninhydrin treatment.

After treating a paper with ninhydrin, it must not be touched by hand; otherwise new fingerprints will develop even if the paper is dry. This is a fact well known to everybody working on the paper chromatography of amino-acids and similar substances. In the presence of a solvent, for example water, contact with fingers gives soft pink spots with no clear lines. Even on dry paper the papillary lines become clearly visible.

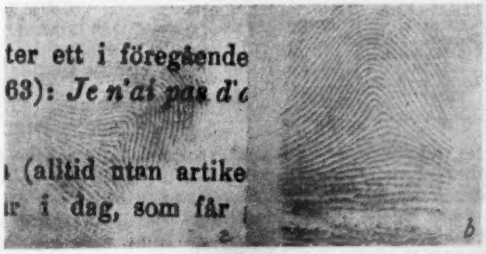

Fig. 1. *a*) A twelve-year old fingerprint in a French grammar; on almost every page fingerprints could be developed by ninhydrin. (*b*) A fresh print is reproduced for comparison

We have been able to develop fingerprints on many kinds of paper, some of which had not been touched for a long time. Fig. 1 shows part of a page of a French grammar which had not been used for twelve years. The owner's fingerprint can be compared with a fresh print developed on sized paper.

We are investigating the ninhydrin reacting compounds in fingerprints and perspiration. Fingerprints have also been made visible with *Amidoschwartz* (Bayer) or other reagents used for the localization of protein spots in paper electrophoresis. This indicates the presence of proteins, probably keratin.

All the details and applications of the method have not been worked out yet; but a full account of problems related to it will be published elsewhere. Part of this work has been carried out at the Institute of Biochemistry, Uppsala, and we are indebted to Prof. A. Tiselius for valuable discussions.

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Dec. 2.

[1] Levy, A. L., and Chung, D., *Anal. Chem.*, **25**, 396 (1953).
[2] Hier, S. W., Cornbleet, T., and Bergeim, O., *J. Biol. Chem.*, **166**, 327 (1946).

Occurrence and Distribution of Sarcosine in the Rock Lobster

The unidentified amino-acid found by us in the rock lobster (*Jasus lalandii*)[1] has been shown to be sarcosine. We are indebted to Mr. R. G. Westall for suggesting that our unknown might be sarcosine and for sending us an authentic sample for comparison.

We had previously considered this possibility, but had rejected it because the R_F values of the unidentified amino-acid in phenol and butanol – acetic acid were appreciably different from the values reported for sarcosine in the literature[2,3] and because it did not give the colour test with *p*-nitrobenzoylchloride described for sarcosine by Plattner and Nager[2]. However, the test also gave negative results with sarcosine in our hands, and a direct comparison of the R_F values of the unknown and sarcosine in different solvents showed them to be identical, as may be seen from the following figures:

Solvent	R_F		
	Unknown	Sarcosine	
		Found	Literature
Phenol – water (70 : 30)	0·88	0·88	0·80 (ref. 2) 0·78 (ref. 3)
Butanol – acetic acid – water (40 : 10 : 23)	0·19	0·19	0·24 (ref. 3)
Lutidine – water (3 : 1)	0·21	0·21	—

The difference between our R_F values and those of other workers may be due to the fact that our chromatograms were of necessity run at 30°.

Final proof of the identity of the unknown was obtained by isolating sarcosine from rock lobster hepatopancreas extract by fractionation on a sulphonated polystyrene resin (nominal divinyl benzene content 4½ per cent)[4]. The fraction containing sarcosine plus aspartic and glutamic acids, asparagine, proline, serine and threonine was chromatographed on a cellulose column using phenol – water (70 : 30) as solvent, and a fraction was obtained which contained only sarcosine and proline. This was crystallized from methanol – acetone[5] to give chromatographically pure sarcosine, melting point 210·5–211·5° (decomp.), undepressed on admixture with the authentic sample. An examination of the infra-red spectra confirmed the identity of the two samples.

Appreciable amounts of sarcosine have been found in trichloracetic acid extracts of the hepatopancreas and blood of the rock lobster; but only traces were found in the muscle extracts. Hydrolysates of the hepatopancreas, blood and muscle proteins did not contain detectable amounts of sarcosine. The distribution of other amino-acids in the muscle and hepatopancreas extracts will be reported elsewhere.

We are aware of only two previous reports of the occurrence of sarcosine in the animal kingdom. It was isolated from the starfish *Astropecten* by Kossel and Edlbacher[5] in 1915, and it has recently been found in elasmobranch fishes by Shewan[6]. We have also found it in the freshwater crab *Potamon* (*Potamonantes*) *perlatus/sydneyi*, and we plan to look for it in other invertebrates.

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[1] Novellie, L., *Nature*, **169**, 968 (1952).
[2] Plattner, Pl. A., and Nager, U., *Helv. chim. Acta*, **31**, 2203 (1948).
[3] Haworth, R. D., MacGillivray, R., and Peacock, D. H., *Nature*, **167**, 1068 (1951).
[4] Shewan, J. M., Fletcher, L. I., Partridge, S. M., and Brimley, R. C., *J. Sci. Food Agric.*, **3**, 394 (1952).
[5] Kossel, A., and Edlbacher, S., *Hoppe-Seyl. Z.*, **94**, 264 (1915).
[6] Rep. Food Invest. Board, London, 39 (1952).

Milk Ejection resulting from Mechanical Stimulation of Mammary Myoepithelium in the Rabbit

There is good experimental evidence in the rabbit[1,2] that the normal removal of milk from the maternal mammary glands during suckling depends on a reflex release of oxytocin from the posterior pituitary gland. Histological studies[3,4] indicate that the oxytocin induces contraction of the mammary myoepithelium, which results in the expulsion of the milk stored in the alveoli and ducts. The present experiments, which were carried out with twelve lactating rabbits, disclosed a subsidiary mechanism of milk ejection which may help to explain the small variable amount of milk yielded to the young when posterior pituitary activity is prevented by denervation of this gland, by anæsthesia[1], and by emotional excitement[5].

The animals were suckled by their litters prior to the experiments. They were anæsthetized with ethanol–urethane[6], the abdomen shaved and a single teat duct of one mammary gland cannulated. Up to 5 ml. of normal saline at 37° C. was introduced through the cannula until the gland segment served by the cannulated duct was sufficiently distended to

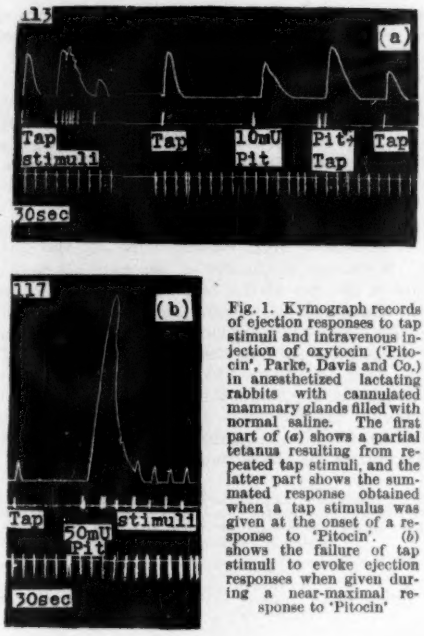

Fig. 1. Kymograph records of ejection responses to tap stimuli and intravenous injection of oxytocin ('Pitocin', Parke, Davis and Co.) in anæsthetized lactating rabbits with cannulated mammary glands filled with normal saline. The first part of (*a*) shows a partial tetanus resulting from repeated tap stimuli, and the latter part shows the summated response obtained when a tap stimulus was given at the onset of a response to 'Pitocin'. (*b*) shows the failure of tap stimuli to evoke ejection responses when given during a near-maximal response to 'Pitocin'

stand out from neighbouring glandular tissue. The cannula was connected to a piston-recorder writing on a kymograph.

A sharp tap delivered with the flat surface of a scalpel handle on the cannulated segment of the mammary gland resulted after a latent period of about 1 sec. in a rise of 1–10 cm. of the fluid in the cannula, representing an ejection volume of 0·06–0·6 ml. The total duration of the response was less than 1 min. (Fig. 1). A succession of taps at intervals of approximately 10 sec. resulted in a partial tetanus and rapid onset of fatigue (Fig. 1*a*). The responses resembled those produced by small doses of oxytocin. When a tap stimulus was given at the onset of a near-threshold dose of oxytocin, a smooth summated response was obtained (Fig. 1*a*). But tap stimuli applied during a response to a near-maximal dose of oxytocin were ineffective (Fig. 1*b*). This result indicates that the responses to hormonal and mechanical stimuli utilize the same effector tissue (myoepithelium).

The response to tap stimuli was not affected by procaine infiltration of the overlying skin, and typical ejection responses could be elicited after removal of a portion of the skin by direct application of the tap stimuli to the exposed mammary tissue. Substitution of 4 per cent procaine for saline in the cannula also did not prevent responses to the tap stimuli. Further, section of the inguinal (external spermatic) nerve supplying sympathetic adrenergic fibres to the inguinal mammary glands did not affect the response in those glands, and electrical stimulation of the peripheral end of the nerve, or injection of adrenaline or *nor*-adrenaline, did not produce an ejection response. These observations favour the view that the tap stimuli activate the contractile elements directly, without nervous intervention.

Other experiments which will be reported in detail elsewhere showed that procedures which stimulate sympathetico-adrenal activity in the rabbit inhibited the milk-ejection response to intravenous injection of oxytocin, but not the response to tap stimuli. These results provide suggestive evidence that the inhibitory effect of sympathetico-adrenal activity[5] is mediated indirectly by mammary vasoconstriction rather than by a direct inhibition of myoepithelial contraction.

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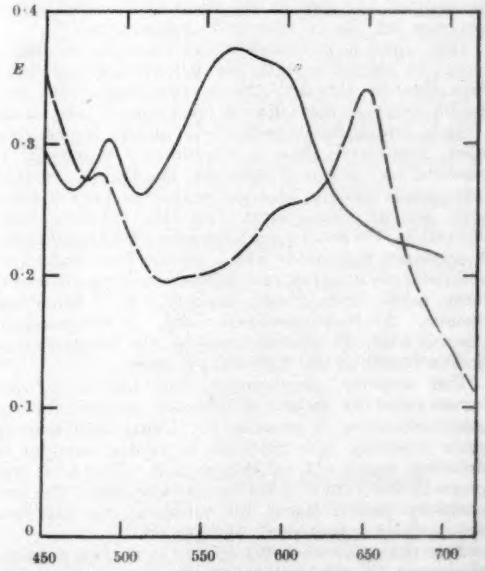
[1] Cross, B. A., and Harris, G. W. *J. Endocrin.*, **8**, 148 (1952).
[2] Cross, B. A., *J. Endocrin.*, **9**, ix (1953).
[3] Richardson, K. C., *Proc. Roy. Soc.*, B, **136**, 30 (1949).
[4] Linzell, J. L., *J. Anat., Lond.*, **86**, 49 (1952).
[5] Cross, B. A., *J. Endocrin.*, **9**, 7 (1953).
[6] Cross, B. A., and Dyke, H. B. van, *J. Endocrin.*, **9**, 232 (1953).

A Biliviolin Metal Complex in Ox Bile

An ethyl acetate extract of fresh ox bile acidified to 5 per cent with concentrated hydrochloric acid yielded a dark green waxy solid on taking to dryness *in vacuo*. Chromatography of this substance from a 2 : 10 methanol – ether solution on a column consisting of a mixture of 12 gm. of acid-washed talc and 3 gm. 'Hyflo' filter-aid gave a single grey-green band which could be partly eluted with methanol. The absorption spectrum of the eluted substance (a green solid) in methanol and in methanolic hydrochloric acid is shown in the accompanying figure. Acidification changed the colour of the solution from green to violet and shifted the absorption maximum from 646 to 568 mμ. A chloroform solution of the compound showed a strong red fluorescence in ultraviolet light. The pigment could not be extracted from



Absorption spectrum of the green pigment obtained by chromatography of an ethyl acetate extract of ox bile, in methanol (– – –), in 5 per cent hydrochloric acid in methanol (———)

chloroform solution with 1 per cent hydrochloric acid, demonstrating that it was biliviolin and not a bilipurpurin complex.

The zinc complex of biliviolin prepared by oxidation of a pure specimen of bilirubin showed an absorption maximum in methanol at 644 mμ shifting to 568 mμ on addition of hydrochloric acid, the colour of the solution changing simultaneously from green to blue-violet.

Biliviolinoid pigments have been observed in dog bile[1] and in gall-stones[2], but have been considered to be almost certainly secondary oxidation products of bilirubin. It is unlikely that the biliviolinoid pigment found in ox bile arises in this way, as its typical absorption spectrum has been found in association with an undistorted bilirubin curve. This suggests that the pigment occurs *per se* in the bile, as oxidation has been found always to be accompanied by distortion of the bilirubin spectrum. Such a compound would probably occur normally in bile in the form of a trace metal complex, for a number of such elements are known to be excreted mainly in the bile, and the *p*H of ox bile (7–8) is such as to allow the formation of metal complexes.

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[1] Beck, A., *Wien. Klin. Wschr.*, **8**, 617 (1895).
[2] Fischer, H., Hilmer, H., Lindner, F., and Pützer, B., *Hoppe-Seyl. Z.*, **150**, 44 (1925).

Stearolic Acid, an Essential Fatty Acid?

According to Bernhard[1], stearolic acid (Δ^9-octadecynoic acid-1; CH_3—$(CH_2)_7$—C≡C—$(CH_2)_7$—COOH) has vitamin F activity, since this acid, when mixed throughout the diet in the form of its ethyl ester, prolongs the life of vitamin F-deficient rats.

This result is in contradiction with our investigations[2], in particular with the '6,9(term.)-hypothesis'. According to this hypothesis, the presence of two double bonds at the 6,9(term.)-positions of fatty acids (that is, double bonds at the 6 : 7- and 9 : 10-positions when numbered from the terminal CH_3-group) is essential for vitamin F activity. The known essential fatty acids, namely, linoleic, linolenic and arachidonic acid, are all characterized by this 6,9(term.)-configuration. On assaying a large number of fatty acids, it appeared that acids which do not have this characteristic are inactive, and further, three new essential fatty acids were found, namely, $\Delta^{10,12}$-nonadecadienoic, $\Delta^{11,14}$-eicosadienoic, and $\Delta^{6,9,12}$-octadecatrienoic acid, all characterized by the occurrence of double bonds at the 6,9(term.)-positions.

The activity of stearolic acid has now been investigated by means of our new method for the standardization of vitamin F. Using this method, male weanling rats received a limited amount of drinking water—14 ml./day/animal. The food was given in the form of a fat-free sucrose diet. The preparatory period lasted for seven weeks, and was followed by a four-week test period.

Five times per week 0·2 ml. of the various preparations was pipetted to groups of twelve and twenty-four animals respectively, except the control group (eleven animals) which received nothing. The groups forming the reference standard received various doses of sunflower-seed oil, which, if necessary, were made up to 0·2 ml. with fully hardened coconut fat, which contains no linoleic acid. The stearolic acid was administered as the ethyl ester. The stearolic acid ester was prepared from oleic acid by bromination to dibromo-oleic acid, followed by dehydrobromination with aqueous potassium hydroxide. The stearolic acid thus obtained melted at 47·2–47·3° C., was free from bromine and optically pure. It was esterified in ethanol/sulphuric acid.

Probably as a result of the longer preparatory period (normally five weeks) some of the animals died. Moreover, a number of the animals developed lesions at the tip of the tail. In its final stage the lesion amounted to a complete necrosis of the tail tip; this stage was assigned the figure 3, while 2 and 1 represented less serious stages, and 0 the normal tail.

The data on the mortality, the tail lesions, and the change in the body-weight during the four-week test period are collected in Table 1. Owing to the mortality, the data regarding the change in the body-weight relate to the surviving animals.

Table 1. Mortality, Extent of Tail Lesions, and Change in the Body-weight of Vitamin F-deficient Animals receiving Different Doses of Sunflower-seed Oil and Stearolic Acid during a Period of Four Weeks

Preparation	Dosage (day/animal)	Mortality	Mean stage tail lesions	Change in body-weight (gm.)
Control	nil	3/11	0·44	−5
Sunflower-seed oil	10 mgm.	0/24	0·00	+18
,, ,,	50 ,,	0/24	0·00	+70
,, ,,	182 ,,	0/12	0·00	+86
Stearolic acid (ethyl ester)	172 ,,	9/12	0·92	−38

In the sunflower-seed oil groups, no deaths or tail lesions occurred, while a distinct growth reaction was observed. Of the controls, three out of eleven animals died, the mean tail lesion was 0·44, and the body-weight of the group decreased slightly (− 5 gm.). Of the twelve animals which received the ethyl stearolate, nine died (significant with regard to the control group), while the tail lesions (stage 0·92) were more serious than in the control group. The stearolate did not give any improvement in the body-weight, but quite the reverse, for a significant decrease in weight was found.

A similar growth retardation in vitamin F-deficient animals has also been observed by Holman[3] with conjugated linoleic acid, as well as in our own investigations[2] with a number of other fatty acids, both saturated and unsaturated.

Summarizing, the present investigation has made it clear that stearolic acid is not able to improve the survival time, tail lesions or growth of vitamin F-deficient animals; on the contrary, it affects them adversely.

I wish to thank the management of Unilever N.V. for permission to publish this work; and Mr. Sparreboom for the preparation and Mr. Duin for the esterification of the stearolic acid.

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Nov. 13.

[1] Bernhard, K., "Le métabolisme des acides gras à triple liaison". Int. Conf. Biochem. Problems of Lipids, Brussels, June 11–13, 1953.
[2] Thomasson, H. J., *Int. Z. Vitaminf.*, **25**, 62 (1953).
[3] Holman, R. T., *Proc. Soc. Exp. Biol. Med.*, **76**, 100 (1951).

Rickets in Sheep

Elliott and Crichton[1] claimed that 'bent-leg' is of widespread distribution in Scotland. They found that cod-liver oil added daily to the diet of young rams less than a year old prevented the appearance of the rachitic condition. These observations were confirmed by Auchinachie and Fraser[2] and by Dunlop[3]. Recent experimental work by Ewer[4] has shown that the rachitic condition occurring in Welsh lambs brought to Cambridge could be prevented by the administration of a single dose of vitamin D_3 (25 mgm. calciferol in 10 ml. arachis oil) given orally to each animal. The protective action of this large dose lasted approximately two months.

On December 20, 1951, at Dalwine Farm, Ayrshire, thirty-eight ram hoggs reared on low-ground pasture from four months of age were individually numbered and weighed. The animals were allotted at random to two groups. One group comprising twenty animals (group *A*) received by mouth two million I.U. vitamin D. The remaining eighteen ram hoggs were retained as controls (group *B*).

The extent of the pasture on which both groups of animals grazed together was 15 acres, which had been ploughed and re-seeded in 1950.

Blood samples drawn from the jugular vein were obtained from ten animals in each group on January 12, and again on February 9, 1952, when the live-weight of the animals in both groups was again determined. The results are shown in Fig. 1. It will be observed that the animals which received supplementary vitamin D in December made a larger gain in live-weight than did the control group.

While vitamin D has been shown to have no effect on growth-rate when ram hoggs already have a sufficient store of the vitamin, half the severely rachitic animals lost weight during the experiment. The late development of the condition in the animal which made the greatest gain in live-weight in the undosed group shows clearly, however, that it is necessary for the animal to increase in live-weight before 'bent-leg' appears. Once rachitic symptoms develop, the animal is unable to move about and feed normally, at pasture or at the trough; consequently, a marked fall in live-weight rapidly follows.

The results of the blood analyses (Fig. 2) showed that whereas the serum calcium level of the dosed group was 11·3 mgm. per 100 ml., the corresponding figure for the control group was 6·73 mgm. calcium. A marked difference was also obvious even a month after dosing in the level of the blood phosphate in the two groups. The figure obtained in the undosed controls was less than 4 mgm. phosphorus per 100 ml.

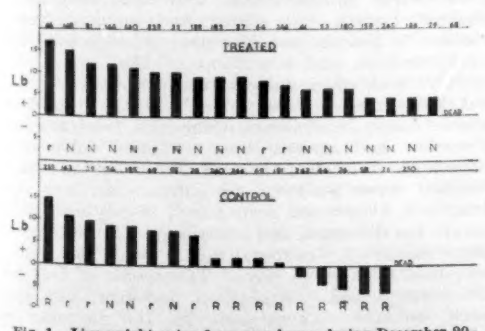

Fig. 1. Live-weight gains from ram hoggs during December 20–February 9. *N*, normal; *r*, rickets; *R*, severe rickets

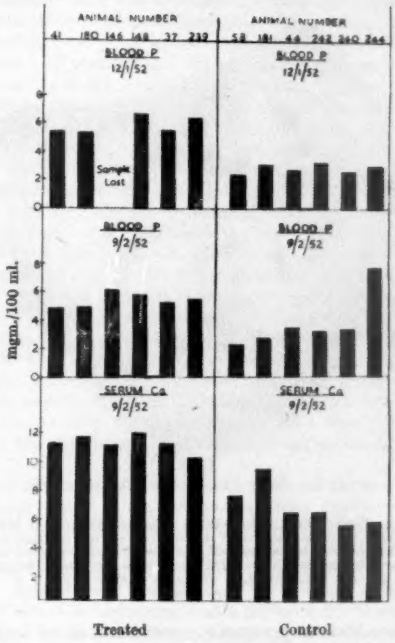

Fig. 2. Blood inorganic phosphorus and serum calcium levels of experimental animals

blood in all cases. In the dosed group, however, the blood analyses showed that the level of blood inorganic phosphorus was greater than 5 mgm. per 100 ml. in every animal. The clinical condition of five treated animals a month after dosing indicated, however, that the rachitic condition was beginning to appear.

Dosing of all the animals on February 9 with two million I.U. vitamin D_3 resulted in recovery and normal health and growth in the affected untreated controls.

It is now general practice in the south of Scotland on hill farms to administer a large dose of vitamin D_3 to the young rams about mid-December and again early in February. At all experimental centres in this area (seven), two administrations during the winter have been found to be necessary.

This treatment has been found to be sufficient to prevent the appearance of the rachitic condition 'bent-leg' during the winter months.

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West of Scotland Agricultural College,
Auchincruive, Ayr. Nov. 19.

[1] Elliott, W., and Crichton, A., *J. Agric. Sci.*, **16**, 65 (1926).
[2] Auchinachie, D. W., and Fraser, A. H. H., *J. Agric. Sci.*, **22**, 560 (1932).
[3] Dunlop, G., *Proc. Nutrit. Soc.*, **4**, 69 (1946).
[4] Ewer, T. K., *Brit. J. Nutrit.*, **5**, 287 (1951).

Cytology of Meiosis in *Matonia*

Matonia pectinata R. Br. is one of the best known examples of a very ancient relict type among living ferns. As is well known[1], the fossil record goes back at least to the Cretaceous period and it extends geographically into the present Arctic Circle, yet the living species is confined to a few isolated mountains in western Malaysia.

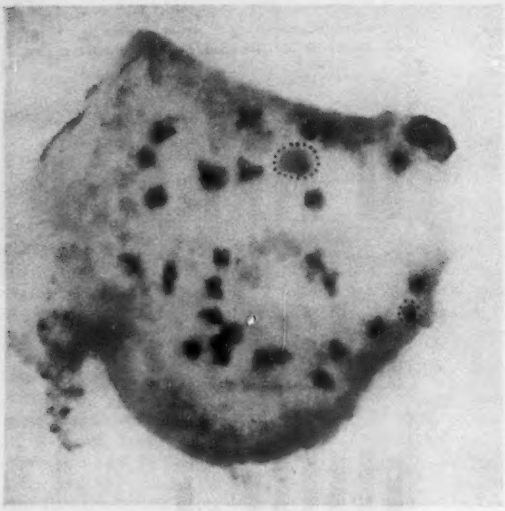

Fig. 1. First meiotic metaphase in a spore mother cell of *Matonia pectinata* photographed with a dry lens in the original aceto-carmine mount to permit all the chromosomes present to be recorded in one focal level. The two bodies surrounded by dotted lines are not chromosomes. There is one nucleolus. × 1,000. $n = 26$

Matonia is at present so specialized in its ecological requirements that it has never been successfully established in cultivation although the spores have recently been germinated by Miss Alma Stokey, who has described the structure and development of the prothalli[2].

The opportunity to study meiosis in this species arose through the co-operation of Prof. R. E. Holttum, of the University of Malaya, who, while conducting a field-course for his own students at Fraser's Hill (Selangor–Pahang boundary) in September of this year, used the opportunity to fix sporangia in the field and to post them to me. *M. pectinata* grows sparingly on Pine Tree Hill (4,800 ft.) just below the summit. Fixings were made on September 26 in 1 : 3 acetic alcohol which had been taken out from England ready mixed on September 9. The material was posted from Singapore on October 3; it was received in Leeds on October 8 and the observations were completed a week later.

The stages of meiosis seen include several cells in early diakinesis and metaphase 1 and one damaged cell in anaphase 1. All the less-perfect cells gave counts of the order of 25; but, as is demonstrated by Fig. 1, the chromosome number in the best cell obtained is unequivocally 26.

It is gratifying to note that 26 was also the number put forward by Stokey and Atkinson[2] on the basis of some mitotic cells in sectioned prothalli.

It is not possible to discuss the significance of this number in detail here; but it is perhaps worth mentioning that before this result was known two species of the *Dicranopteris* section of *Gleichenia*, from Malaya and Ceylon respectively, had independently given counts of 39 and 78 [3]. Since *Gleichenia* has a fossil record of the same type and age as that of *Matonia* and has, moreover, long been thought to be related to it, it is perhaps not mere coincidence that both genera should possess chromosome numbers which are multiples of the same number, namely, 13.

This subject will be discussed further in a forthcoming paper by I. Manton and W. A. Sledge on the cytology of the ferns of Ceylon. *Matonia* does not, however, occur in Ceylon, and it is therefore perhaps desirable to record the facts for it in a separate note in view of the exceptional botanical interest of the genus.

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Dec. 31.

[1] Bower, F. O., "The Ferns", 2 (Cambridge, 1926).
[2] Stokey, A. G., and Atkinson, L. R., *Phytomorphology*, 2, 138 (1952).
[3] Manton, I. (unpublished).

Chlamydospores and Survival in Soil Fungi

Many of the fungi found in soil are centred around particles of organic debris[1,2], and from these food bases the fungi may spread into the soil matrix to a greater or lesser extent[3]. It is not known how far the fungi in the soil are dependent upon the undissolved organic matter or to what degree the nutrients in the soil solution support their growth. The work described in this communication forms part of an investigation into this question. The dilute solutions in which the fungi were grown were based on the formula given by Erikson[4]. To this inorganic artificial soil solution dextrose was added to give solutions varying from 0·005 gm./l. to 0·02 gm./l., so that the solutions might simulate a considerable range of true soil solutions. A 0·2-ml. drop of the dilute nutrient solution was placed on the surface of a clean microscope slide resting on a bent glass support in a Petri dish, the base of which contained 5 ml. sterile distilled water. A loopful, containing 20–25 conidia, of a washed spore suspension of the fungus under test was added to the culture drop, and the dishes incubated on the laboratory bench at 17·0–24·4° C. Microscopic observation of the subsequent development was made over a period of fourteen days, after staining with acid fuchsin/lactophenol. *Botrytis cinerea* Pers., *Mycogone perniciosa* Magn., *Trichoderma viride* Pers. ex. Fr., *Trichothecium roseum* Link., *Fusarium oxysporum* Schl. var. *cubense* (E. F. Sm.) Wollenweber and Reinking, and *Stemphylium sarcinaeforme* (Cav.) Wilts. were the fungi used.

The amount of growth produced in the artificial soil solutions varied with the concentration of dextrose, but the morphological features of the colonies were identical in all the artificial soil solutions. In *Trichoderma*, *Trichothecium*, *Fusarium* and *Stemphylium*, growth was strong and macroscopically visible. In *Botrytis* and *Mycogone* the mycelium was more tenuous, and branching of the hyphæ was sparse. In all cases, growth was continuous throughout the period of observation and the cytoplasm stained deeply. Sporulation occurred in *Trichothecium*, *Fusarium* and *Stemphylium*. Control cultures of *Mycogone*, *Trichothecium* and *Fusarium* in glass-distilled water produced germlings with short, unbranched, attenuated germ-tubes, the cytoplasm of which was disrupted and unstaining. On plating out these cultures it was found that no viable structures remained after seven days. The spores of *Botrytis*, *Trichoderma* and *Stemphylium*, however, produced small colonies characterized by the presence of terminal and intercalary swollen cells. These bodies

had a distinct double wall and the contents stained deeply in contrast to cells of the same colony with normal diameter which contained only unstaining, disrupted cytoplasm. Little further growth occurred after this stage had been reached, but on plating out the cultures normal colonies developed on the agar and, on inspection at an early stage, were seen to originate from the swollen cells of the distilled water cultures. The characters of these swollen cells agree with the criteria of chlamydospores as given by Langeron[5].

A Seitz-filtered solution obtained from soil by displacement with water, when used as the culture liquid in place of artificial soil solution, gave restricted colonies which were morphologically identical with controls in glass-distilled water. The three fungi which had produced chlamydospores and remained viable in distilled water behaved in the same way here, while those which retained the usual morphology died. In a Seitz-filtered 1 : 5 water-extract of the same soil, development followed closely that taking place in Seitz-filtered artificial soil solution, growth continuing without the production of chlamydospores. The total dissolved solids in the displaced solution were greater than four times those in the water-extract, and the oxidizable organic matter greater than five times that in the water-extract. It seems probable that the characteristic development in the displaced solution was due to the presence of an inhibitory factor rather than to a shortage of nutrients.

Seitz-filtered displaced soil solution was amended with sterile dextrose solutions to give two concentrations of enriched displaced solution containing 0·01 gm./l. and 0·05 gm./l. dextrose respectively. Displaced soil solution which had been diluted an equal amount with sterile distilled water was used as control, and colonies in this solution developed exactly as in the undiluted solution. In both enriched solutions *Botrytis*, *Mycogone*, *Fusarium* and *Stemphylium* developed as in the artificial soil solutions. *Trichothecium* showed a partial inhibition with production of malformed conidiophores in the solution containing least dextrose. *Trichoderma* showed evidence of inhibition in both enriched solutions by the production of chlamydospores, and a reduced but continuous growth-rate. The level of dextrose in the enriched solutions was greater than that in the artificial soil solutions, yet in some cases the inhibition was still observed. The poor development in the displaced solution, then, is not due to lack of energy substances. In a displaced soil solution which had been autoclaved at 121° C. for 20 min. before Seitz-filtering, normal growth of a type morphologically identical with that found in the artificial soil solutions was obtained. The growth-rates of colonies in this solution were comparable with those of colonies in artificial soil solutions. This suggests that the abnormal development in the unautoclaved displaced soil solution was due to the presence of a naturally occurring toxin which is removed or destroyed by the heat treatment.

Concentrated washed suspensions of spores of *Botrytis*, *Trichoderma* and *Stemphylium* in distilled water were prepared with a spore density of $1 \cdot 6 \times 10^6$/litre. Drops of these suspensions were used as culture drops in an experiment to discover the effect of increased population density on the development of chlamydospores. Controls with 20–25 spores in each culture drop were set up in the normal way. Chlamydospore formation was greatly increased in all three species and was associated with a corresponding decrease in hyphal development. Under these highly populated conditions, in fact, the colonies were largely composed of numbers of chlamydospores loosely held together by short lengths of moribund hyphæ. In a further experiment to determine the effect of adverse conditions on the morphology of fungi of poor nutritional status, cultures of the six fungi were set up in drops of artificial soil solution in the usual way and immediately inoculated with a 23-hr. broth of an aerobic, non-spore-forming bacillus previously isolated from soil. Four of the test fungi were unaffected by the presence of this other organism and continued growth in a normal manner. Germination of *Trichoderma* and *Trichothecium* was considerably reduced by the treatment. *Trichoderma*, which had the capacity to produce chlamydospores, developed these bodies and remained viable with little further growth, while with *Trichothecium* the germ-tubes became markedly attenuated and ceased to grow after the second day. After four days the cultures of this fungus failed to produce colonies on plating out.

From these results it appears that, in three of the six fungi used, chlamydospores were produced in response to an adverse environment, being absent under favourable cultural conditions. Morphological features of this type have been reported to develop under sub-optimal conditions by other workers. Elliott[6] noted a darkening and a nodular development on fungal hyphæ growing in the presence of bacterial contamination. Koch[7] observed that chlamydospores were formed by *Dibotryon morbosum* on potato-dextrose agar only near certain other organisms, one of which has since been shown to produce an antibiotic, or when toxic inorganic salts were added to the culture. In the present study the development of chlamydospores was associated with the ability to remain viable under conditions lethal to fungi lacking the capacity of producing them. Venkat Ram[8] found that certain bacteria stimulate chlamydospore formation in *Fusarium solani*. He suggested that the phenomenon was due to the production of antibiotics by the bacteria and that it might be of importance in the survival of *Fusaria* in soils. Of the three fungi here found to have the capacity of producing chlamydospores, *Trichoderma* and *Stemphylium* were freshly isolated from soil. The remaining four fungi had been subcultured on agar for a number of years. It is suggested that the ability to produce resistant chlamydospores under adverse conditions, by extending the period of survival of a fungus in soil, may increase the probability of isolation of the fungus from soil. Thus strains possessing this ability will have a greater chance of being classified as members of the soil microflora.

I wish to express my thanks to Prof. C. W. Wardlaw, under whose supervision this work was carried out.

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Feb. 4.

[1] Chesters, C. G. C., *Trans. Brit. Mycol. Soc.*, **30**, 100 (1948).
[2] Warcup, J. H., *Trans. Brit. Mycol. Soc.*, **34**, 376 (1951).
[3] Garrett, S. D., "Root Disease Fungi" (Chronica Botanica, U.S.A., 1944).
[4] Erikson, D., *J. Gen. Microbiol.*, **1**, 45 (1947).
[5] Langeron, M., "Précis de Mycologie" (Masson et Cie., Paris, 1952).
[6] Elliott, J. A., *Amer. J. Bot.*, **4**, 439 (1917).
[7] Koch, L. W., *Sci. Agric.*, **15**, 80 (1934).
[8] Venkat Ram, C. S., *Nature*, **170**, 899 (1952).

Shot-hole Disease of Stone Fruits caused by *Clasterosporium carpophilum*

Pure cultures of the fungus *Clasterosporium carpophilum* were isolated from recent infections of peach leaves and fruits. Isolation trials showed that the fungus is viable in leaf lesions from March until September. For this purpose, infected parts were washed thoroughly in sterile water and small portions of the diseased tissues were placed on corn-meal agar at 25° C. Hyphal tips were taken from the edge of the growing colonies and these were left to grow on corn-meal slants. In some cases, infected portions were sterilized using, first, 1 per cent silver nitrate solution for two minutes and then sodium chloride for 3–4 minutes and then washing thoroughly in sterile water.

Pathogenicity tests gave successful results by inoculating young peach seedlings (with 8–10 leaves) with a spore suspension of the fungus. Pricking the leaves was essential for getting clear symptoms in a week's time. High humidity was secured by covering the inoculated plants with bell-jars for three days after infection.

The rate of disease-spread was studied in the field. It was shown that the symptoms begin to appear in March (after leaf growth), the severity of the disease rises gradually until May, slows down slightly until September and then rises gradually until the end of the season.

The disease starts more severely in March after wet winters than after dry ones.

Control measures by spraying with Bordeaux mixture 4 : 6 : 50 or 4 : 6 : 100 at flowering time and at setting of fruits were not successful; neither was spraying with 20 or 10 per cent lime-sulphur at the above spraying dates.

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M. E. Allam

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References

Cunningham, G. H., "Fungus Diseases of Fruit Trees" (Brett Printing and Publishing Co., Ltd., Auckland, New Zealand, 1925).
Welsh, M. F., *Proc. Canad. Phytopath. Soc.*, 17, 12 (1950).
Wilson, E. E., Univ. Calif. Coll. Agric. Exp. Sta. Bull. 608 (1937).

A Variable Morphological Character of *Trichomonas vaginalis*

Several comprehensive morphological studies of *Trichomonas vaginalis* have been published[1]. In none is mention made of a striking morphological character I have observed in three different strains of *T. vaginalis*. These strains were originally isolated from vaginal material gathered at the Whitechapel Clinic from patients with vaginitis and are now growing on artificial culture media[2].

The character takes the form of a variable thickening and rigidity of the terminal one-fourth to one-third of one of the four anterior flagella (Fig. 1). The presence and conspicuousness of this club-like structure varies between strains and between individuals in the same strain. It is conspicuous in most individuals in the *W*-2 strain, where it was first noticed; conspicuous but somewhat less frequent in the *W*-1 strain; least frequent in the *W*-3 strain. In the fourth strain, obtained from Dr. M. G. McEntegart, of the Liverpool City Laboratories, and which has now been in artificial culture for more than two years, the character appears to be absent.

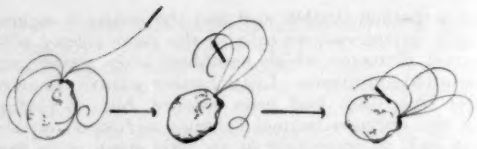

Fig. 1. Clubbed flagellum of *Trichomonas vaginalis* in an active organism

Between individuals, the character varies in conspicuousness from a well-defined rod, about two to three times the diameter of the ordinary flagellum, down to a thin structure which is the same diameter as the rest of the flagellum and is manifested solely by its inflexibility. Characteristically, a single clubbed flagellum is found on an organism. In many individuals it is absent or undetectable; rarely two clubbed flagella are found in a single set of four, but never more than two.

In dividing forms with two sets of flagella I have found several combinations of the clubbing feature: one club in each set of flagella; a clubbed flagellum in one set only; apparent absence of clubbing in both sets.

While it can be observed in those dead organisms in which the flagella are not obscured, clubbing is best seen in the living organism. A 43 × objective with a 10 × eyepiece (or 5 × for greater depth of focus) make a good combination for detecting the character. It is most striking in dark-field preparations, in which the clubbed portion of the flagellum appears brightly luminous.

The clubbed structure was also found in a fresh vaginal specimen. Though difficult to observe because of the large amount of obscuring tissue debris and the extremely active state of the flagella, clubs were present in a small number of the organisms. The structure is not, therefore, a variation arising in artificial culture, but is an intrinsic, if variable, morphological character of *T. vaginalis*.

The function of the club-like flagellar structure of *T. vaginalis* is, at this stage, open to conjecture. Thickening of the tip of a flagellum has been noted in *Leptomonas ctenocephali*[3], in which the enlargement is slimy in character and serves as an organ of attachment. The flagellar club of *T. vaginalis*, however, does not appear to be slimy or sticky. Another difference between the two is that in *L. ctenocephali* the thickened flagellum is much shortened, whereas in *T. vaginalis* the clubbed flagellum is never shorter, and at times appears to be longer, than its three associated flagella.

These preliminary observations are recorded to bring this hitherto unreported character of *T. vaginalis* to the notice of protozoal morphologists as a possible additional distinguishing character for the species.

I am indebted to Dr. A. J. King, senior physician of the Whitechapel Clinic, London Hospital, for permission to obtain clinical specimens. Miss Ann Laffy made the drawing.

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[1] Powell, W. N., *J. Hygiene*, **24**, 145 (1936). Wenrich, D. H., *Amer. J. Trop. Med.*, 24, 39 (1944). Trussell, R. E., "Trichomonas Vaginalis" (Blackwell Scientific Publications, Ltd., Oxford, 1947).
[2] Feinberg, J. G., *Nature*, **171**, 1165 (1953).
[3] Lwoff, A., *Zentral. f. Bakt.*, **130**, 498 (1930).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 8

UNIVERSITY COLLEGE LONDON, DEPARTMENT OF BIOCHEMISTRY (in the Physiology Theatre, Gower Street, London, W.C.1), at 4.45 p.m.—Prof. F. Lynen (Munich): "The Participation of Coenzyme A in the Metabolism of Fat".*

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "How can Electrical Methods Enhance Industrial Productivity".

Tuesday, March 9

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. D. V. Arnold: "Libraries: Some Problems in Communication".*

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2), at 2.15 p.m.—Mr. E. R. Hoare: "The Development of Spraying Machines in this Country and Overseas and Methods of Assessing their Performance".*

ROYAL SOCIETY OF MEDICINE, EXPERIMENTAL MEDICINE AND THERAPEUTICS SECTION (at 1 Wimpole Street, London, W.1), at 4.30 p.m.—Prof. G. A. H. Buttle: "Pharmacology and Experimental Medicine" (Presidential Address).

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS, LONDON CENTRE (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. F. F. Roberts and Mr. H. G. Bassett: "The Theory and Application of Transistors".

INSTITUTE OF THE RUBBER INDUSTRY, LONDON SECTION (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. S. S. Pickles: "Some Recollections of Events and Personalities in the Rubber Industry, 1903–1953".

ILLUMINATING ENGINEERING SOCIETY (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. J. B. Collins and Mr. R. G. Hopkinson: "Flicker in Relation to Interior Lighting".

SOCIETY FOR ANALYTICAL CHEMISTRY, PHYSICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Meeting on "Refractometry and Interferometry".

Wednesday, March 10

ROYAL AERONAUTICAL SOCIETY (at the Salle des Anciens Elèves des Ecoles d'Arts et Métiers, 9 bis avenue d'Iléna, Paris), at 5 p.m.—Mr. R. Hafner: "The Domain of the Helicopter" (the 7th Louis Bleriot Lecture).

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Prof. E. A. Müller (Dortmund): "Man at Work, a Physiological Analysis".* (Further Lectures on March 11 and 12.)

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. A. Cameron: "Surface Failure in Gears".*

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. G. H. R. von Koenigswald (Utrecht): "The Pithecanthropus Problem"; March 11: "Java and Early Man"; March 12: "The Position of the South African Australopithecinae".*

OVERSEAS SCIENCE STUDENTS ASSOCIATION (at the Society for Visiting Scientists, Ltd., 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Prof. P. B. Medawar, F.R.S.: "Skin Grafting and Individuality".

Thursday, March 11

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Geoffrey Taylor, F.R.S.: "The Dispersion of Matter in a Turbulent Fluid Flowing through a Pipe"; Mr. J. Darbyshire: "Structure of Microseismic Waves".

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. R. W. Willett: "Mineral Resources of the British Commonwealth: Some Recent Developments".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. C. W. Miller: "An 8-MeV. Linear Accelerator for X-Ray Therapy".

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (joint meeting with ACTON TECHNICAL COLLEGE SCIENTIFIC SOCIETY, at Acton Technical College, High Street, Acton, London, W.3), at 7 p.m.—Prof. D. H. Hey: "Developments in the Chemistry of Free Radicals".

Friday, March 12

ASLIB (at the Royal Society of Arts, 8 John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Miss D. Slocombe and Miss M. Dean-Smith: "The Use and Abuse of Sound Recording".

INSTITUTE OF PHYSICS, INDUSTRIAL RADIOLOGY GROUP (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. F. I. G. Rawlins: "The X-Ray Examination of Museum Objects".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Mr. Hayne Constant, F.R.S.: "The Search for Lightness".

Saturday, March 13

NUTRITION SOCIETY (at University College Hospital Medical School, University Street, London, W.C.1), at 10.30 a.m.—Symposium on "Some Problems of Nutrition".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT (with good training in bacteriology and an appropriate qualification, and preferably with experience in the dairy industry) IN THE BACTERIOLOGY DEPARTMENT, for work on bacterial spores in milk and general creamery hygiene—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting 54/2 (March 13).

ASSISTANT LECTURER IN AGRICULTURAL ECONOMICS—The Registrar, The University, Leeds 2 (March 13).

LECTURER, Grade II, IN MATHEMATICS, at University College, Ibadan, Nigeria—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1 (March 15).

LECTURER IN MATHEMATICS at Fourah Bay College, Sierra Leone (University of Durham)—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (March 15).

RESEARCH FELLOW IN CHEMISTRY—The Registrar, University College, Singleton Park, Swansea (March 15).

RESEARCH FELLOW IN METALLURGY—The Registrar, The University, Sheffield (March 15).

SENIOR LECTURER or LECTURER (Grade A) IN MATHEMATICS, SENIOR LECTURER or LECTURER (Grade A) IN PHYSICS, and a LECTURER (Grade A) IN BOTANY, at Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (March 22).

LECTURER (with a good honours degree and some relevant experience, preferably in the fields of reinforced concrete, soil machines or surveying) IN THE DEPARTMENT OF CIVIL ENGINEERING—The Registrar, The University, Bristol 8 (March 24).

LECTURER (with special qualifications in physical chemistry) IN CHEMISTRY, and a LECTURER (with special qualifications in organic chemistry) IN CHEMISTRY—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (March 27).

SCIENTIST (with a good honours degree or equivalent, and preferably with general experience in coal chemistry and spectroscopic techniques) for work in connexion with infra-red and ultra-violet spectroscopy—The National Coal Board, Central Research Establishment, Stoke Orchard, near Cheltenham, Glos., quoting TT/746 (March 27).

TUTOR (honours graduate in science) IN THE DEPARTMENT OF EXTRA-MURAL EDUCATION, University of Glasgow, for duties which will consist mainly of conducting and organizing classes in adult education—The Director of Extra-mural Studies, 91 Oakfield Avenue, Glasgow, W.2 (March 29).

LECTURER IN GEOGRAPHY—The Secretary, Queen's University, Belfast (March 31).

SENIOR LECTURER IN INORGANIC AND PHYSICAL CHEMISTRY at the University of Adelaide, Adelaide, South Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Adelaide, March 31).

LECTURER IN BACTERIOLOGY at the Western Infirmary, Glasgow—The Secretary of University Court, The University, Glasgow (April 3).

VIROLOGIST (honours graduate, with qualifications in plant pathology, and preferably with postgraduate experience in methods of plant virus research) AT THE SCOTTISH PLANT BREEDING STATION—The Secretary, Scottish Society for Research in Plant Breeding, Craigs House, Corstorphine, Edinburgh 12 (April 3).

LECTURER IN APPLIED MATHEMATICS—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (April 17).

ENGINEERS and PHYSICISTS, Senior Scientific Officer and Scientific Officer grades (with an appropriate first- or second-class honours degree, or equivalent high professional attainments) in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth, Weymouth and Gloucestershire areas, and Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.246/52/A/R.5.

JUNIOR RESEARCH FELLOW IN MATHEMATICS or some branch of the PHYSICAL or BIOLOGICAL SCIENCES—The College Secretary, Balliol College, Oxford.

LECTURER (preferably with a knowledge of agricultural subjects) IN NUTRITION—The Secretary, Queen Elizabeth College, Campden Hill Road, London, W.8.

MASTER TO TEACH CHEMISTRY at least to advanced level with subsidiary Physics or Mathematics—The Headmaster, Westminster School, 17 Dean's Yard, London, S.W.1.

MASTER TO TEACH MATHEMATICS up to scholarship standard—The Headmaster, Wrekin College, Wellington, Shropshire.

SCIENTIFIC OFFICER (with an honours degree in science, preferably physics, and with experience in meteorology) at the Royal Observatory, Hong Kong, for forecasting, research, etc.—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.57/51/03.

SENIOR EXPERIMENTAL OFFICER (with at least H.S.C. (including physics), or equivalent, but preferably with a degree in physics) to be responsible for the organization and supervision of operations involving the processing of active materials; and for the accounting and movement control of active materials used by a research and development group—The Administrative Officer, Recruitment, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 20/W.G.E.

SENIOR EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER (with at least H.S.C. (science) or equivalent, but preferably with a pass degree in science) for chemical engineering calculations, design and specification writing—The Administrative Officer, Recruitment, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 19/W.G.E.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with an honours degree in physics or electrical engineering or equivalent, and a detailed knowledge of ultra high-speed pulse techniques, and able to carry out design, development and engineering of special instruments using such techniques) at the Atomic Weapons Research Establishment, Fort Halstead—The Administrative Officer, Recruitment, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 22/W.G.E.